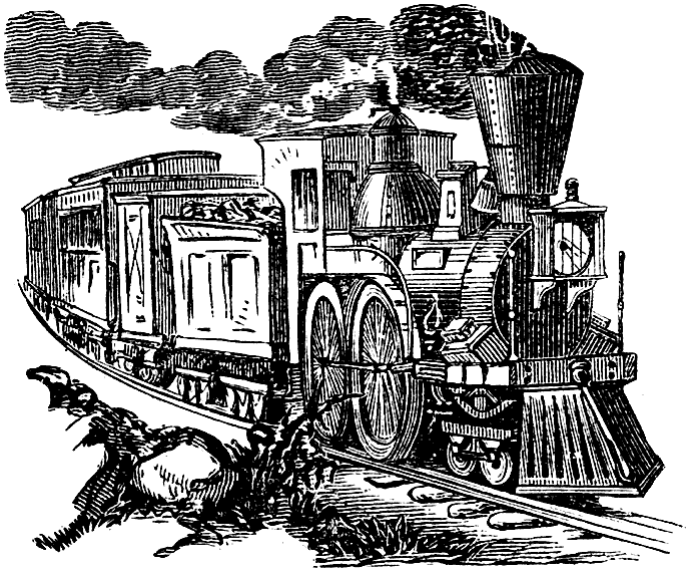
Unit 1: Forces & Motion

- **Lesson 1: Motion in one direction**
- **Lesson 2: Graphic representation of motion in one direction**
- **Lesson 3: Scalar & vector physical quantities**



Lesson 1: Motion in one direction

Introduction:

In 1964, The Bullet Train started working. This train is an electric train & reaches a speed of 270km/h. Each cart has its own engine, that is why it is so fast.

Motion is the change of the position of a body as time passes relative to the position of another object.

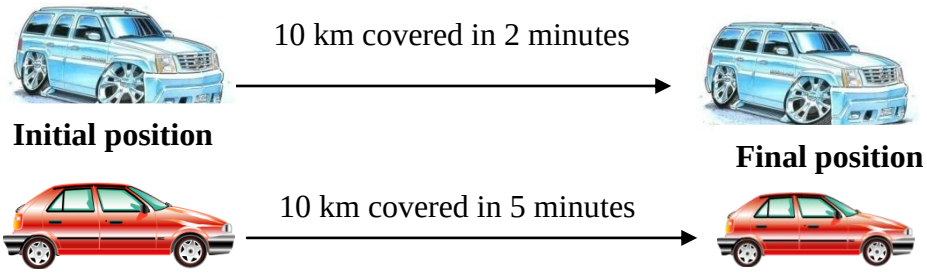
- **To simplify motion we'll consider motion in one direction.** One example is the motion of a train on a straight track. The train moves either forward or backward along the track. It can't move left or right or up or down.
- The train is moving in a straight line because its path is straight. Motion in a straight line is the simplest type of motion.

✓ **Speed**

What are the factors which affect speed?

Consider the following: Two cars are moving on the same path. The 1st car covered 10 km in 2 minutes while the 2nd car covered the same distance (10 km) in 5 minutes. Which car is faster?

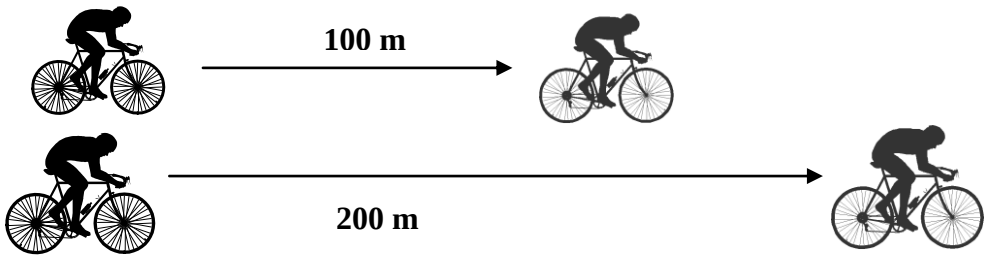
The 1st car is faster because it covered the same distance in a shorter time.



Two objects moving with different speed cover a certain distance in different intervals of time. The object which spends the least time has the biggest speed.

Consider the following: Two persons are riding their bikes along the same path.

- The 1st biker covered 100 m & the 2nd covered 200 m. Both took the same time.
- Which one has the highest speed?



- The speed of the 2nd biker is bigger because he covered a bigger distance in an interval of time equal to the 1st biker.

Conclusion:

The speed of the moving object depends on 2 factors:
a.the distance covered
b. the time taken.

Speed is the distance covered in a unit time

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} = \frac{\Delta d}{\Delta t}$$

Note: The units of speed are km/h or m/s

Enriching information:
1 km = 1000 m
1 hour = 60 minute
1 minute = 60 seconds

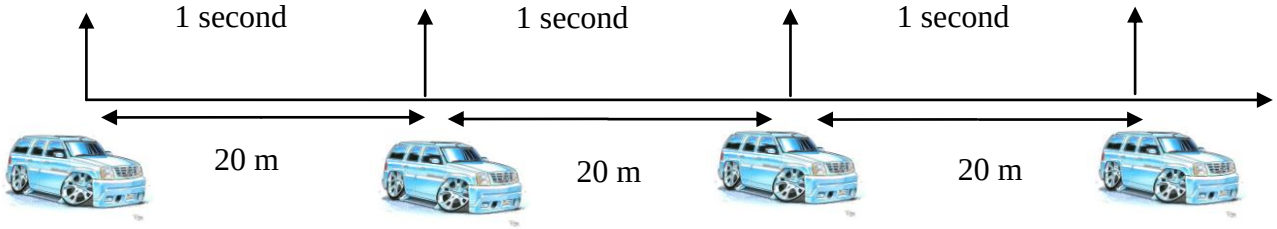
$$\text{Speed km/h} \times \frac{1000}{60 \times 60} = \text{speed m/s}$$

How to change the speed of unit km/h to m/s.
Speed km/h x 5⁄18 = speed m/s.
Example speed of 72 km/h = $72 \times \frac{5}{18} = 20$ m/s

Uniform Speed = Regular Speed

The speed of an object is uniform if it covers equal distances in equal intervals of time.

An Example:
The car in the figure covers 20 m in the 1st second & 20 m in the 2nd second
& another 20 m in the 3rd second.



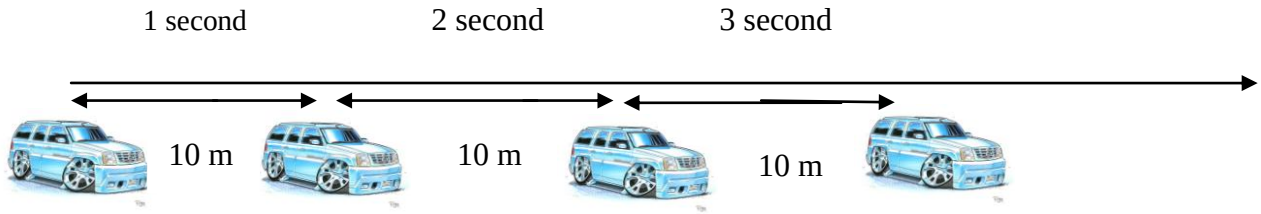
Cars & planes are provided with counters such as **speedometers , mileage, hour timers** & **compasses** The speedometer identify the speed of the car or plane during navigation.

Speedometer

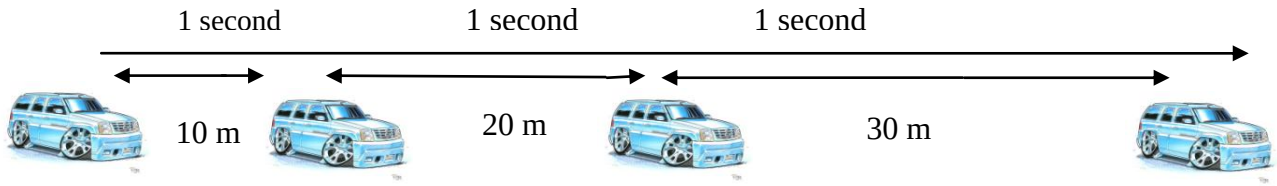
Gas mileage

Non-Uniform Speed = Irregular Speed

1.The speed is non-uniform when a moving object covers equal distances in variable intervals of time.



2. When a moving object covers variable distances in equal intervals of time, its speed is non-uniform.



Average Speed

- Consider a car trip from your home to a place 100 km away along a straight road . You took an hour to reach your destiny. You probably decreased your speed at certain moments then stopped in front of a red light then increased your speed again. Your speed through the trip is non-uniform.
- Your average speed through the whole trip = distance covered ÷ time taken
- Therefore the average speed of this trip = 100km/1hour = 100km/h

The average speed equals the constant speed needed to cover the given distance in a given time interval.

- This value is average. You probably traveled slower than 100km/h at other times.
- Average speed = $\frac{\text{Total distance}}{\text{Total time}}$
- The average speed is equal to the constant speed needed to cover the given distance in a given time interval.
- For a car moving with regular speed, its regular speed = the average speed.
- When the car is moving with irregular speed, its average speed isn't equal to the regular speed because its motion is irregular.

Relative Speed

- The diagrams below show two cars moving along the same straight road .The speed of car B is 80 km/h & the speed of car A is 10km/h .
- For an observer who is in car B , the speed of car A is only 10 km/h

80km/h 90km/h

- For an observer standing on the pavement, the speed of car A = 80km/h while the speed of car B = 90km/h.
- Measuring the speed depends on the position of the observer who is determining the magnitude (value) of the speed.
- Relative speed depends on the position of the observer.

Relative speed is the speed of a moving object relative to an observer.

Lesson2:
Graphic representation of motion in a straight line

Physicists use graphs to describe physical quantities.

A toy car starts its motion from rest where the speed = 0

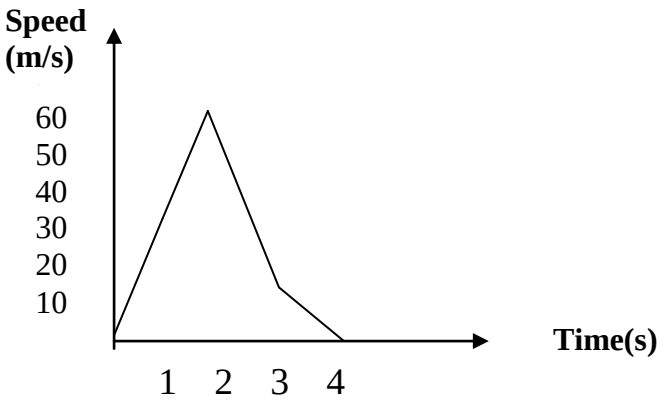
In the 1st s, the speed=30 m/s.

In the 2nd s, the speed=60m/s.

In the 3rd s, the speed falls to 20m/s.

After 4 sec. , the car stops moving.

The motion of the car could be represented by the following graph:



Graph of non-uniform speed

What do you conclude from the graph?

- The speed of the toy car increases during the first 2 seconds**.**
- The speed of the toy car decreaese during the last 2seconds.

Therefore the car is moving with non-uniform speed.

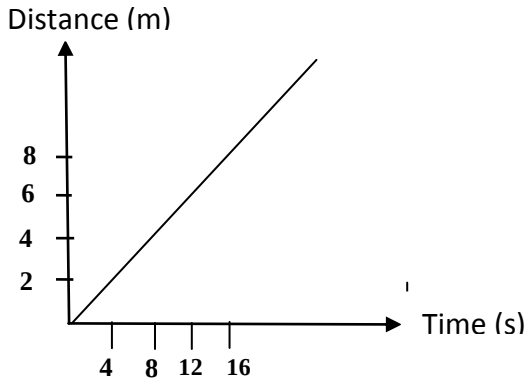
Graphs are used to represent the relation between speed & time.

Representing uniform speed by graphs.

The following table contains some data that describes the motion of a toy car.

Time (s)	Distance(m)	speed d/t
4	2	½
8	4	½
12	6	½
16	8	½

Let's plot the data in the table in a graph where the x axis represents time & y axis is the distance.



The graph of distance versus time for motion with uniform speed is a straight line starting with the point of origin.

Note: The origin point is also called the point of intersection of the x & y axes.

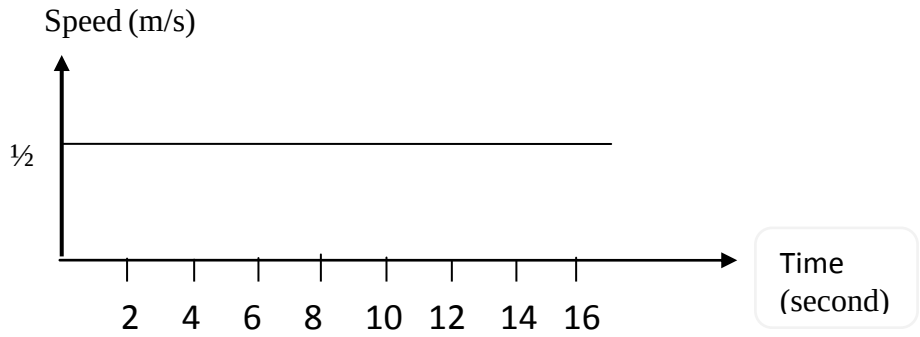
From the graph , you can conclude the following:

1. The distance is directly proportional to the time.
2. The ratio between the distance & time is constant.
3. The car is moving with uniform speed.

The following table shows the relation between the speed of the car & time.

steps	Time(s)	Speed (m/s)
1	4	½
2	8	½
3	12	½
4	16	½

The following graph represents the relation between the speed of the car & the time



The graph of speed versus time for uniform motion is a straight line parallel to the time axis.

Acceleration

A car is moving with a speed that increases with time.

speed	Time
3m/s	1 second
6m/s	2 seconds
9m/s	3 seconds
12m/s	4 seconds

The speed of the car is increasing with a regular rate, or is accelerating.

Acceleration is the rate of change of the car's speed in a certain time period.

$$\mathbf{A = \frac{\Delta v}{\Delta t} = \frac{final\ speed - initial\ speed}{Time}}$$

Δ is the symbol of the Greek letter delta & it means change.

Definition: acceleration is the change of speed in one second.

- If the body is increasing its speed, the body is **accelerating**.
- If the body is decreasing its speed, then the body is **decelerating (or decreasing acceleration)**.
- The unit of acceleration is m/s^2

An example:

A car is at rest. It then accelerates & its speed reaches 60m/s in 5 seconds. Another car also starts its motion from rest & its speed reaches 80 m/s in 10 seconds.

Which car is accelerating more?

Solution:

Acceleration = $\frac{\Delta v}{\Delta t}$

Car 1 Acceleration = $\frac{60}{5}$ = 12 m/s^2

Car 2 Acceleration = $\frac{80}{10}$ = 8 m/s^2

The 1st car is accelerating more than the 2nd car (i.e. the rate of change of the speed of the 1st car is bigger).

Uniform Acceleration

The following table records the speed of an object versus time intervals. The object starts its moving from rest.

Time (s)	Speed m/s	Acceleration m/s^2
0	0	-
5	10	1
10	20	1
15	30	1
20	40	1
25	50	1

1. The speed increases 10m/s every 5 seconds therefore you can calculate the increase in the speed every 1 s as follows: $v_f - v_i / \Delta t$
2. Note: v_f is the final velocity, v_i is the same velocity at the beginning of motion & since the object wes at rest, then $v_i = 0$
3. The acceleration is (uniform) constant because the speed changes by equal amounts in equal time intervals.

Uniform acceleration is the change in the velocity value by equal values in equal time intervals.

Note: Uniform deceleration occurs when the velocity decreases by equal values in equal time intervals.

<u>An example</u>:

A bus is moving in a straight line with a speed 6 m/s. Its speed increases to 12m/s during a period of 3 seconds, what's the acceleration of the bus?

Solution:

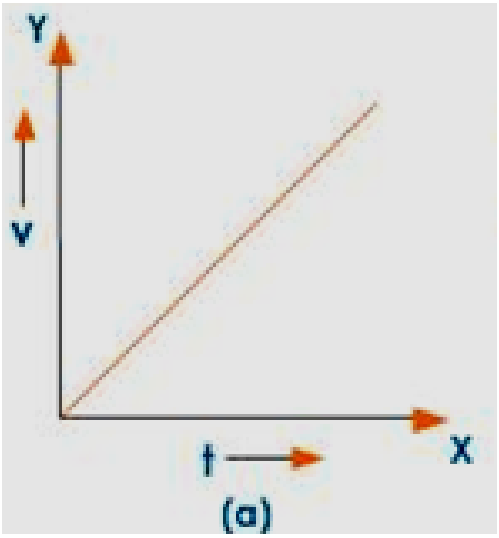
$$\text{Acceleration} = \frac{V_f - V_i}{\Delta t}$$

$A = (12-6) \div 3$

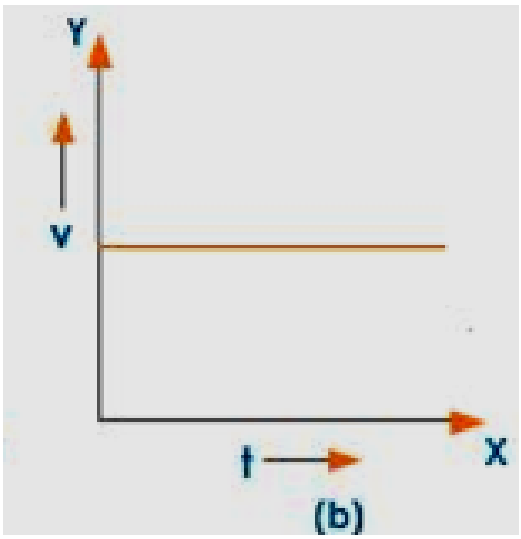
$A = 2\ m/s^2$

Non-uniform acceleration is the change in the velocity by unequal (variable) values in equal time intervals.

Graphs of acceleration

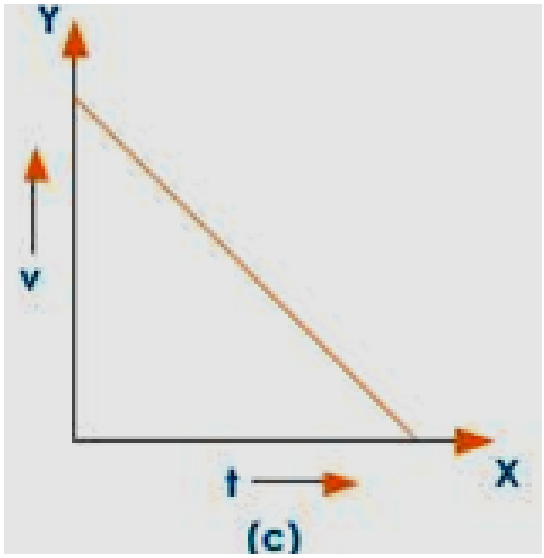


a) The object is moving with uniform acceleration (since the graph is a straight line. Changes in velocity in equal intervals of time is constant.

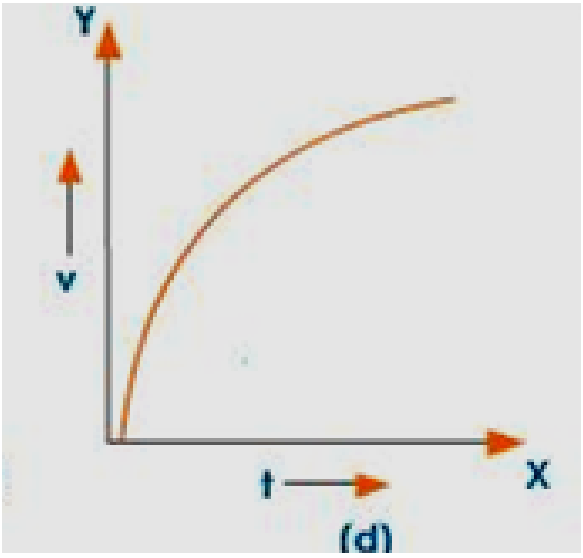


b) The object has zero acceleration since the object is moving with uniform velocity.

Enriching information



c) The object is moving with negative acceleration or deceleration (since the velocity decreases and finally becomes zero)



d) The object is moving with variable acceleration (since the change in velocity is not equal)

Lesson 3: Scalar & vector physical quantities

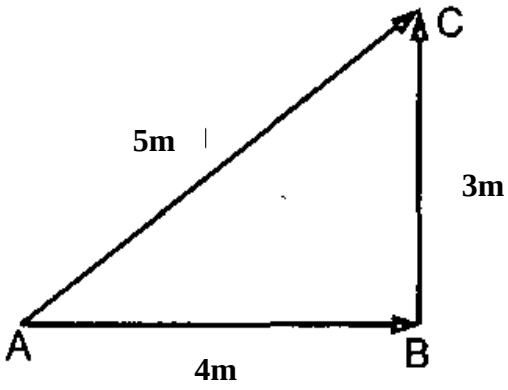
- The study of physics requires describing physical quantities accurately.
- Mass, length, force & time are physical quantities.
- Each physical quantity has its unit.
- Some physical quantities such as time & mass are accurately described with a magnitude (numerical value) only. Such quantities are called **scalar physical quantities.**
- Other physical quantities such as force, velocity , displacement & acceleration are described by magnitude & direction. Such physical quantities are called **vector physical quantities.**

	Scalar physical quantities	**Vector physical quantities**
Definition	It has a magnitude only.	It has a magnitude & direction.
Examples:	mass (kg) length & distance (m) time(s) speed (m/s) density g/cm^3	force (Newton) Acceleration & gravitational acceleration(m/s^2) displacement (m) velocity (m/s)

- **Enriching information**: Scalar quantities which have the same units are added or subtracted according to the mathematical rules that apply to numbers. An example : A time interval of 2 minutes is added to another time interval of
  4 minutes & the result is 6 minutes.
- Vectors are added or subtracted in a different way called vector algebra.
- Studying gravity & the movement of liquids depends on the properties of vectors.

Distance & displacement

- Remember that motion is the change of the position of an object over time.
- Consider a situation, in which a person starts moving from point A first and moves 4m towards B along the line AB as in the figure.
- Then at B, he starts moving along BC (at right angles to AB) and moves a distance 3 m. Thus he has travelled a distance of 4 + 3 = 7 m to reach at point C, starting from point A.
- To know the shortest distance from A to C Join AC. The displacement AC can be obtained using Pythagoras theorem,
- $AC^2 = AB^2 + BC^2 = (4)^2 + (3)^2 = 16 + 9 = 25$ AC = 5 m
- AC is the displacement of the person from A to C.
- Thus when a body moves from one point to another, the distance travelled refers to the actual length of the path whereas the displacement represents the straight-line path between initial and final position. Distance is a scalar quantity, whereas, displacement is a vector quantity.



- While mentioning displacement of a body, we have to specify the direction along which distance is to be measured.
- Both distance and displacement involve measurement of length. They are measured in unit of length. The distance and displacement are equal only if motion is along a straight path. The magnitude of displacement is less than or equal to the actual path covered by the body.

	Displacement	Distance
Definition	The length of the shortest straight line between 2 positions	It's the change of position along the whole path covered by the body.
Scalar or vector	Vector which has a magnitude & direction which describes the motion from the primary position towards the final position	Scalar quantity which has a magnitude only.

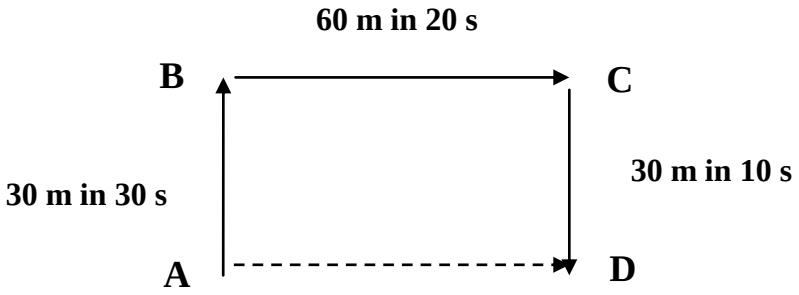
Velocity & speed:

Velocity describes motion with both a direction & a numerical value (magnitude) however speed has only magnitude but no direction.

	Speed	Velocity
Definition	Distance covered in one unit of time	Displacement travelled in one unit of time
Scalar or vector quantity	Scalar with a magnitude only	Vector with both magnitude & direction
Units	m/s or Km/h	
An example	A car moves with speed 50 km/h	A car moves with velocity 50 km/h east
Mathematical relationship	Average speed = $\frac{\text{Total distance}}{\text{Total time}}$	Average Velocity = $\frac{\text{Displacement}}{\text{Total time}}$

An example

An object starts moving from point A towards point B then C then D.



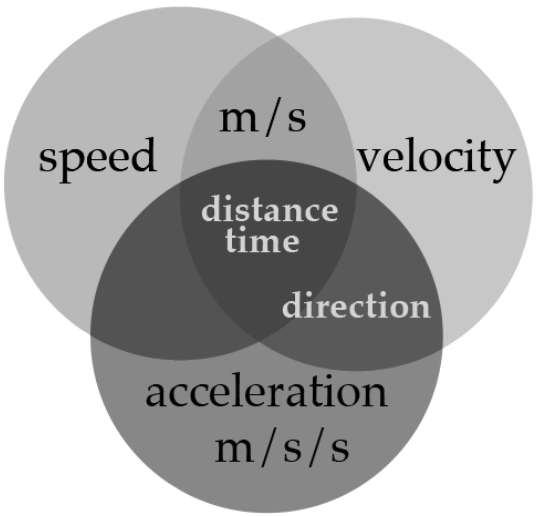
The average speed of this object = total distance / total time

$\overline{V} = \frac{30 + 60 + 30}{30 + 20 + 10}$

= 120/60 = 2 m/s

The average velocity = $\frac{\text{Displacement}}{\text{Total Time}}$

= $\frac{60}{(30 + 20 + 10)}$ = 1m/s



Activity : How long does it take sun light to reach the earth?

The distance between the sun & earth = 149×10^6 km
Light travels at regular (constant) speed = 300,000 km/s

Speed of light = distance ÷ time

Time = distance ÷ speed of light

Time = 149,000 ÷ 300,000 = 496 s
496 ÷ 60 = 8.27 minutes = 8 minutes & 27 s
Therefore if the sun sets at 5 o'clock, light started its journey from the sun at
5.00 – 8.27 = 4.51 o'clock.

Enriching information:

How Wind Affects the Speed of an Airplane:

- The speed of an airplane is directly impacted by wind speed and direction. Before each flight the pilot gets forecasted wind speed and direction to determine the estimated ground speed of the aircraft and calculate the amount of fuel needed for the trip.
- Ground speed is how fast the airplane is traveling over the ground.
- Flying directly into the wind will cause the ground speed to be slower because of air resistance.
- Flying with a wind from behind will cause the ground speed to be faster.
- Therefore the first plane flying will consume more fuel in comparison with the second plane because of the air resistance.

Unit 2: Light energy
Mirrors & lenses
Lesson 1: Mirrors

Light:

- Light is a kind of energy which causes the sensation of vision.
- Sources of light are the sun, the lamps.
- **Some of the properties of light**

  Light travels in straight lines.

  When light falls on a reflecting surface such as a mirror, it reflects back.

  Light refracts when it passes from one transparent medium to another.
- Mirrors have many uses in daily life.
- **A mirror is a shiny smooth surface that bounces off (reflects) light.**
- The surface of still water in a pond acts as a mirror because an image of objects is formed on its surface.

Mirrors have 2 kinds:

Plane (flat) mirrors
(they have flat surfaces)
Their uses:
- Personal grooming.
- Decorating a building.

Spherical mirrors (their surfaces are curved)
Their uses:
- Car's side view mirrors.
- Car's rear view mirror shows the view behind the driver.
- In a barber shop & beauty salons to enlarge the face of the customer.
- In light houses at marine ports.
- In airports.

A Mirror focuses the light of the lamp

Car's rear view mirror

Light reflection:

Activity 1:

Purpose: To conclude the laws of light reflection using a plane mirror.

Materials:

A plane mirror, a white sheet of paper, some pins, a protractor, a pencil & a ruler.

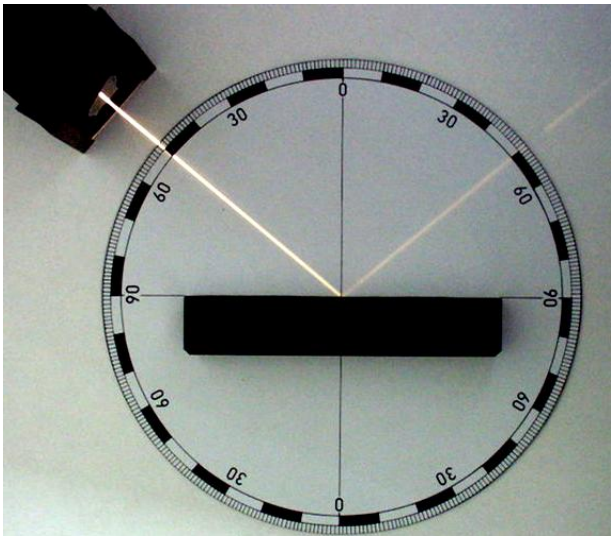
Steps:

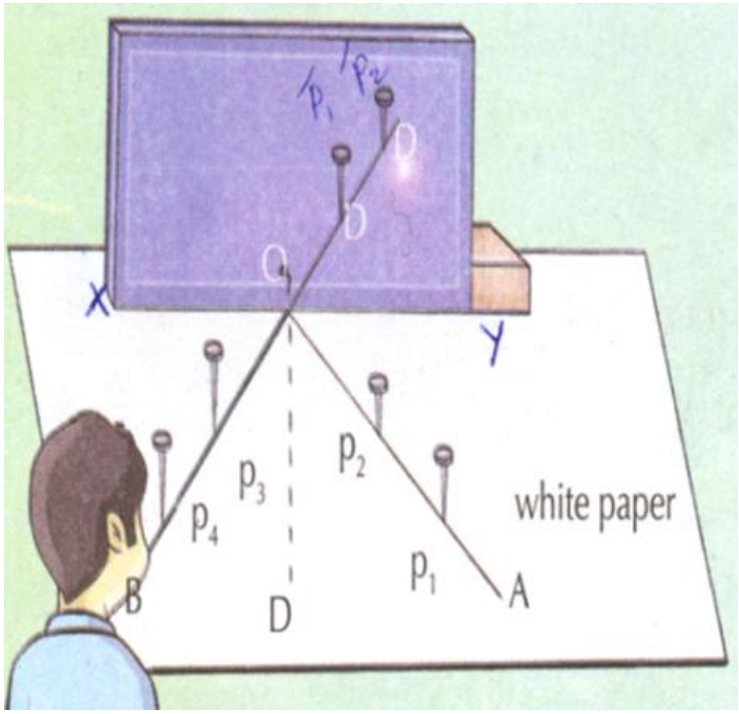
1. Draw a straight line (xy) on a white piece of paper. Place the mirror perpendicular to the piece of paper on line (xy)
2. Draw a line OD perpendicular to the line xy. OD is the normal to the mirror.
3. Draw line AO which represents the incident light ray.
4. Place 2 pins on line AO.
5. Look at the other side of the mirror & observe the images of the 2 pins.
6. Draw a straight line continuous with the image of the pins & meets the mirror at point O.
7. Measure the angle between the reflected ray & the normal with the mirror. This angle is the angle of reflection.
8. Change the angle of incidence by changing the positions of the pins & measure the angle of incidence & the angle of reflection each time & compare their values.

Conclusion: Laws of light reflection:

1st law : the angle of incidence = the angle of reflection.

2nd law: The incident light ray, the reflected ray and the normal to the reflecting surface lie in the same plane.





Concepts of light reflection:

1. **Definition of light reflection**: when an incident light ray falls on a reflecting surface, it bounces back in the same medium.
2. **The incident ray** is the light ray that falls on a reflecting surface such as a mirror.
3. When light falls on a reflected surface (such as a mirror), it's reflected in the same medium.
4. **The reflected ray** is the light ray that bounces back from the reflecting surface.
5. **The angle of incidence** is the angle between the incident ray & the normal.
6. **The angle of reflection** is the angle between the reflected ray & the normal.

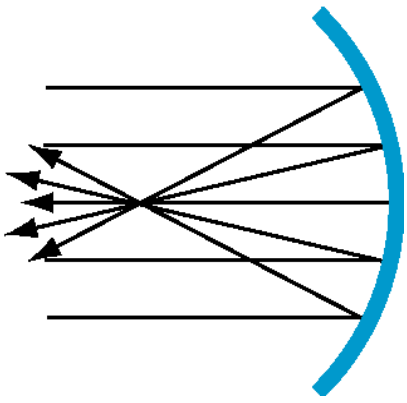
The properties of an image formed by a plane mirror:

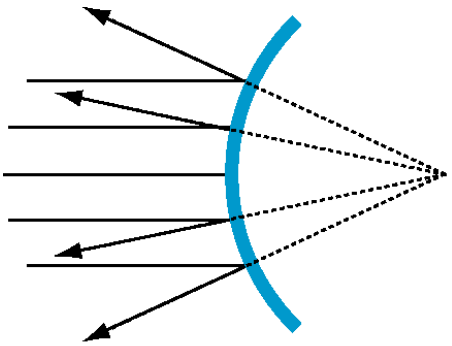
1. Upright
2. Laterally inverted
3. Equal in size to the object.
4. Virtual (can't be received on a screen)
5. The distance between the object & the mirror = the distance between the image & the mirror.

Spherical mirrors

The reflecting surface of a spherical mirror is a part of a hollow sphere.

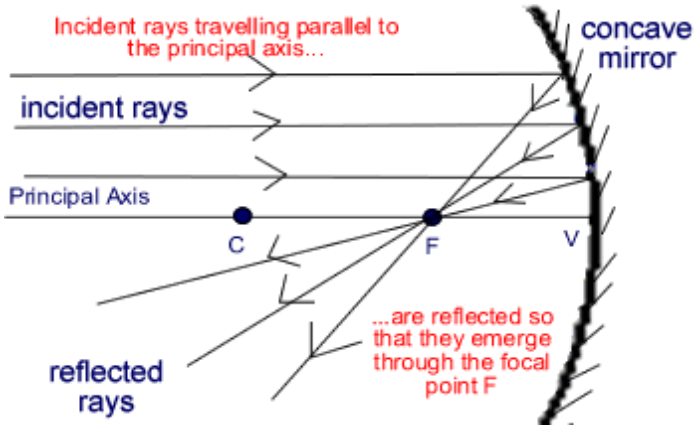
The concave (converging) mirror	The convex (diverging) mirror
It converges (collects) light rays.	It diverges (scatters) light rays.
The reflecting surface is the inner surface of the sphere.	The reflecting surface is the outer surface of the sphere.





Definitions:

1. **Centre of curvature: (C)** is the center of the sphere that the mirror is part of. The center of the **concave mirror** is **in front of the mirror** while the center of the **convex mirror** is **behind** the convex mirror.
2. **Radius of curvature:** is the radius of the sphere that the mirror is part of.
3. **The pole (P)** is the point in the middle of the reflecting surface of the mirror.
4. **The principle axis (CP)** is the straight line that passes through the center of curvature (C) and the pole (P).
5. **The secondary axis** is the line that passes through the center of curvature (C) and any point on the surface of the mirror except the pole (P).
6. The **focus** is the point of collection of the reflected rays (when these rays fall parallel to the principle axis).
   The **rays coming from a distant source** like the sun fall on the mirror **parallel** as in the figure



An activity to determine the focal length of the concave mirror

Steps:

1.Place a mirror facing the sun or a distant object.

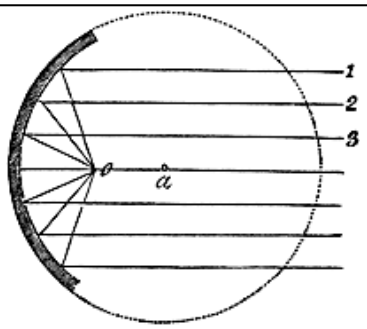
2. Move the screen in front of the reflecting surface of the mirror to obtain the sharpest & brightest image (a lit point).

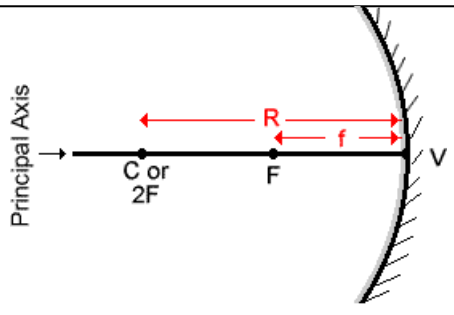
3. Measure the distance between the lit point & the pole of the mirror, this distance is the **focal length (f)** of the concave mirror.

Conclusion:

- The reflected rays collect in a point & is received on a screen. This point is the focus.
- The **focal length** is the distance between the focus & the pole.

  the focal length = ½ the radius of the curvature

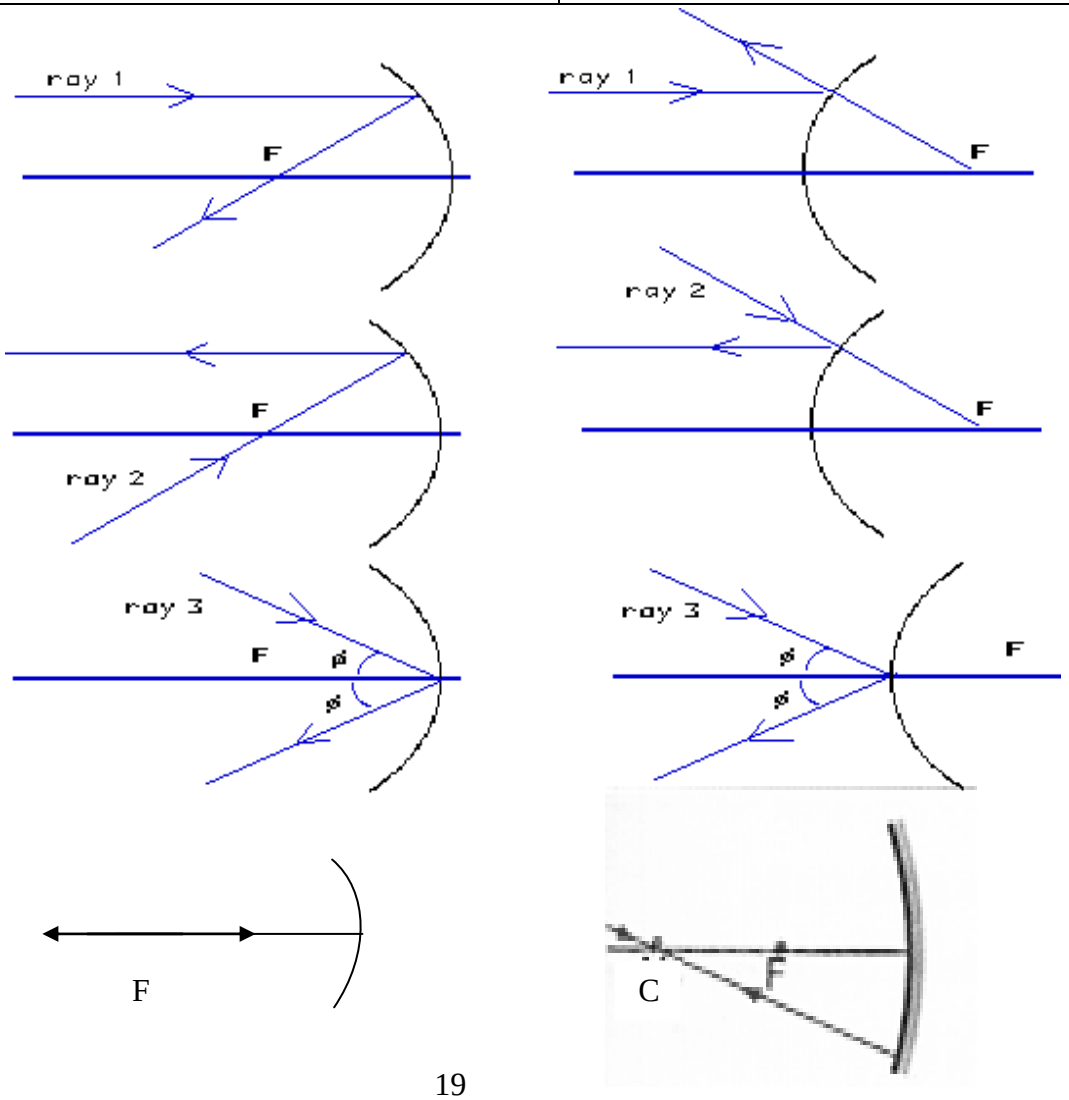




The Principle axis of a spherical mirror	The secondary axis of a spherical mirror
1. It's the line that passes through the center of curvature (C) and the pole (P).	1. It's the line that passes through the center of curvature (C) and any point on the surface of the mirror except the pole (P).
2. There's only one principle axis for a spherical mirror	2. There are many (uncountable) number of secondary axes.

The path of light reflected from a spherical mirror

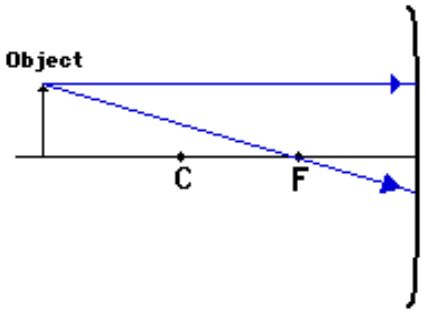
The incident ray	The reflected ray
1. The ray that falls parallel to the principle	Passes through the focus.
2. The ray passing through the focus	Parallel to the principle axis.
3. The ray falling on any point on the surface of the mirror surface	It reflects so that the angle of incidence = the angle of
4. The ray passing through the curvature	On itself.



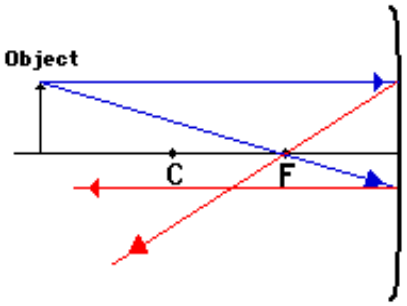
The real image	The virtual image
1. It's formed of the intersection of the reflected light rays. 2. It can be received on a screen. 3. It's always inverted.	1. It's formed of the intersection of the extension of the reflected rays. 2. It can't be received on a screen. 3. It's always upright (erect).

Step-by-Step Method for Drawing Ray Diagrams

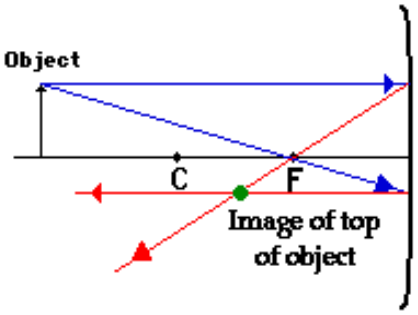
1



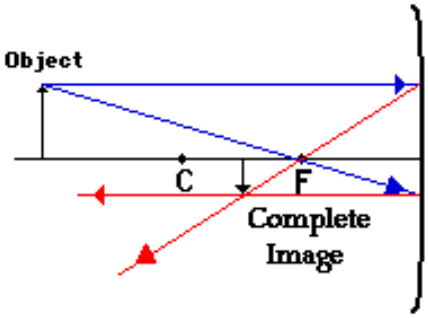
2



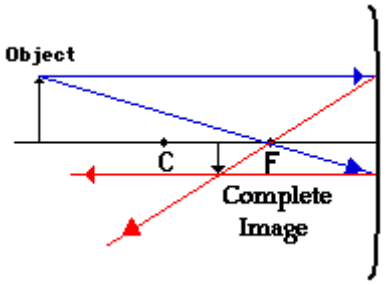
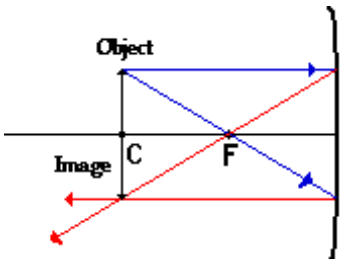
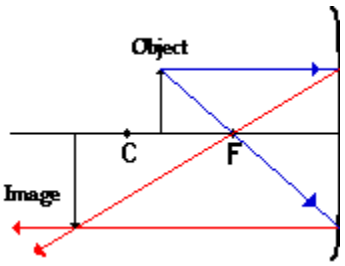
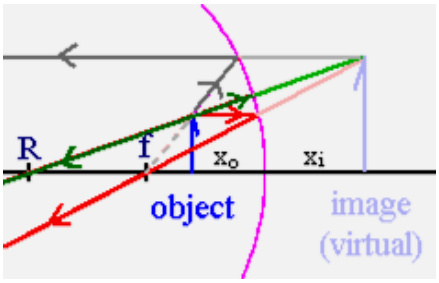
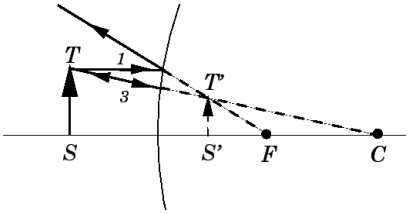
3



4

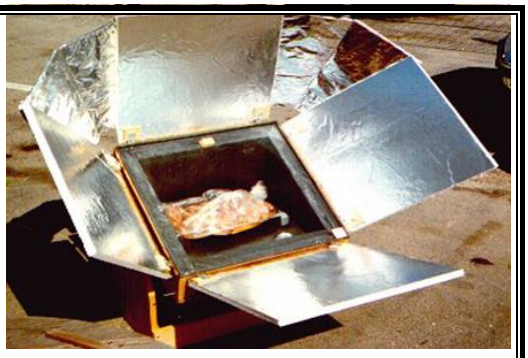


Images formed by a concave mirror

Position of the object	Position of the image	The properties of the image	Drawings
1. At a distance more than the radius of curvature (i.e. a distance larger than double the focal length)	Between the focus & the centre	• Real • Inverted • Smaller than the object	
2. At the center of curvature (i.e. at a distance = double the focal length)	At the center of curvature	• Real • Inverted • Equal in size to the object	
3. Between Center C & the focus F (i.e. at a distance < double the focal length)	At a distance greater than the radius	• Real • Inverted • Larger than the object	
4. Between the focus & the pole (i.e. at a distance less tan than the focal length)	Behind the mirror	• Virtual • Upright • Magnified	
5. An object very far away	At the focus	• Very small	

The uses of concave mirrors

Solar ovens which collect & concentrate sun rays at the focus & generate heat to cook food without need for burning fuel & polluting the environment, hence solar energy is a clean source of energy.

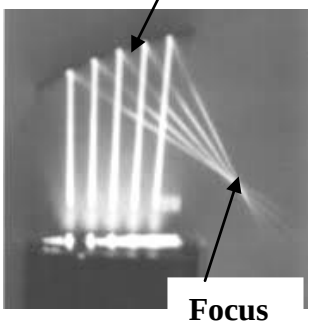


An activity

Purpose: to determine the radius of the concave mirror & deduce the focal length.

Steps:

1. Place the mirror on a holder in front of the light source (description: a box which contains a bulb & light shines through a tiny opening)
2. Move the mirror at different distances until you get an image equal in size to the original spot of light.
3. Measure the distance between the mirror & the opening of the box.



Conclusion

The **focal length** is the distance between the focus & the pole.

the focal length = ½ the radius of the curvature

Formation of images by convex mirrors

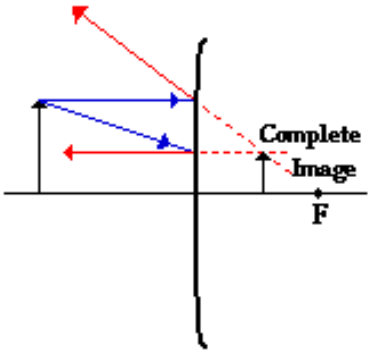
The convex mirror diverges light therefore the image they form have different properties:

- ❖ The image is smaller than the object.
- ❖ Upright (erect)
- ❖ Virtual (not received on a screen)

Uses of convex mirrors:

1. The rear view mirror in the car & side view mirrors are convex mirrors because they form erect images smaller than the cars behind the driver. The driver also looks in the mirrors before he turns right or left & when he parks the car.

The image of the car behind the driver is formed in the side view mirror



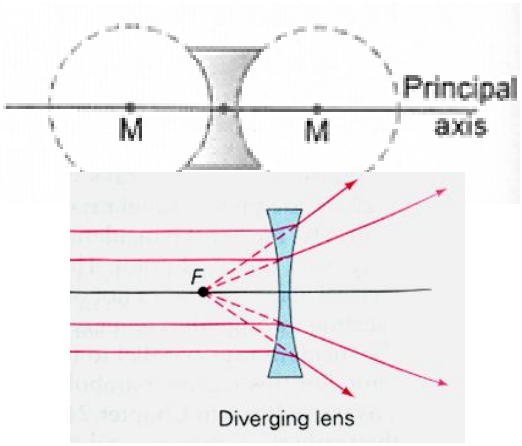
Enriching information: Image formed by the convex mirror

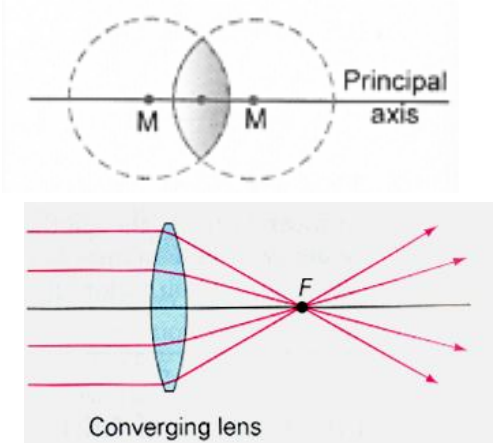
Lesson 2: Lenses

Image of a plant seen through a convex lens

- **A lens is** a transparent medium (glass or plastic) which has spherical surfaces (faces) which refract light.
- **The uses of lenses:**
  a. medical eyeglasses (needed to see things clearly during reading or doing daily activities such as walking)
  b. magnifying lenses are used to fix watches
  c. Leaders watch battle field using binoculars (magnifying glasses).
  d. In telescope that study planets.
  e. In microscopes.
- **Types of lenses**

Concave lens	Convex lens
1. The centre is thin & it thickens towards the tips. **2. Diverges (scatters) light rays.** **3. It has a virtual focus .**	**1. The centre is thick & it thins towards the tips.** **2. Converges (collects) light rays.** **3. It has a real focus**





- The **centre of curvature** of the lens (C) is the centre of the sphere which the lens is part of.
- The **optical centre** is the midpoint between the two faces of the lens on the principle axis.
- **The principle axis of the lens** is the line joining the two centers of curvature of the two spherical faces of the lens.
- The **focus** of the lens is the point of intersection of the parallel light rays after their refraction.
- The **radius** of the lens is the radius or (half the diameter) of the sphere where the lens is part of.
- The focal length is the distance between the focus & the optical center of the lens.

The focus & focal length

Sun rays that pass through the lens, collect at one point called **focus** of the lens.

An activity:

Purpose: To determine the focal length of the convex lens.

Materials: convex lens, screen, lens holder, distant source of light (the sun).

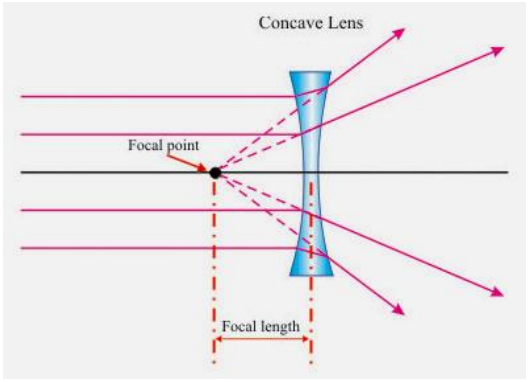
Steps:

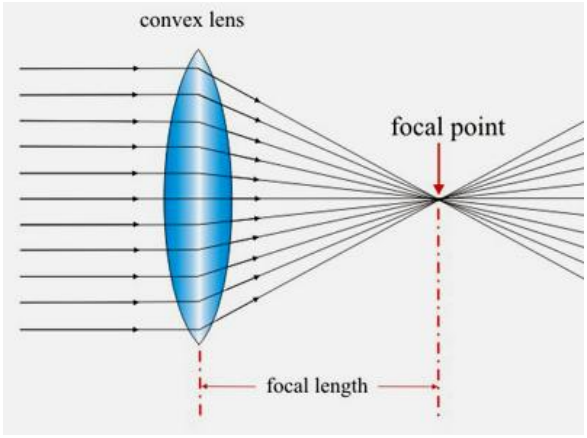
1. Place the lens on a holder facing the sun.
2. Place a horizontal screen on the other side of the lens. Move the screen until you get a sharp spot light which is the image of the sun. This point is the focus of the lens.
3. Measure the distance between this point & the lens which is the focal length.

Conclusion:

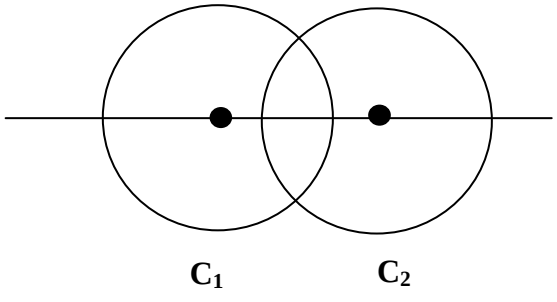
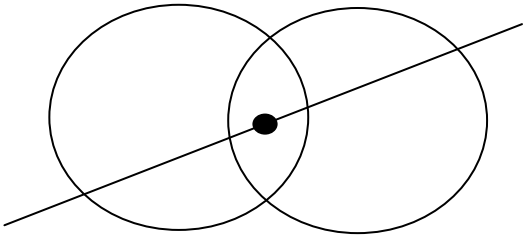
1- Convex lens is a converging lens as it collects the refracted rays.
2- Point of collection of parallel rays refracted by the lens is the focus.
3- Distance between the focus of the lens & its optical center is the focal length of the lens F.

$$F = \frac{1}{2} R$$

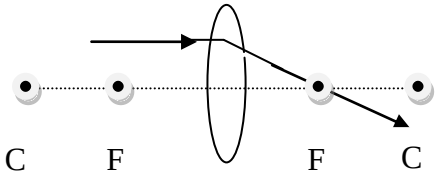
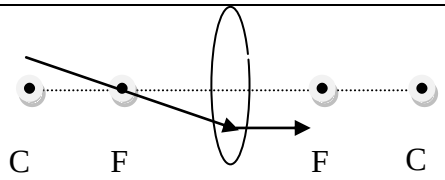
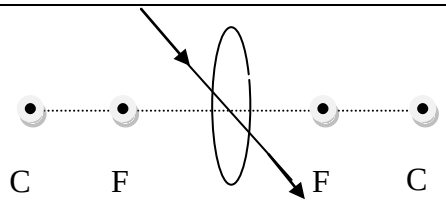




Comparison between the principle axis & the secondary axis

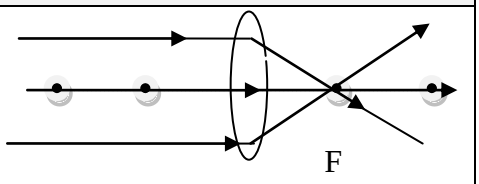
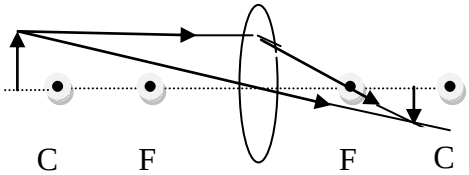
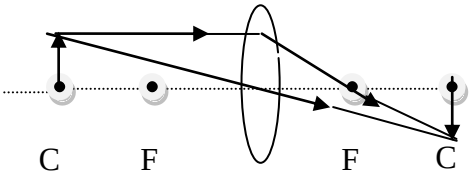
The principle axis	The secondary axis
• It's the line joining the two centers of curvature of the two spherical faces of the lens. • There's only 1 principle axis.  	• It's any line passing through the optical center of the lens except the principle axis. • There're many secondary axes. 

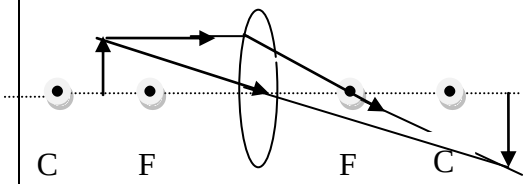
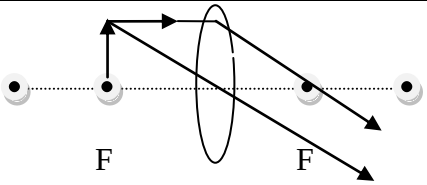
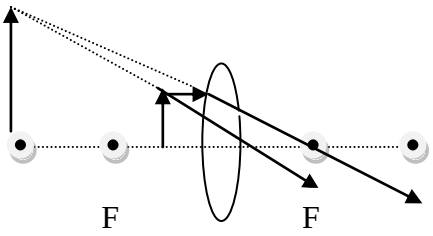
The path of light passing through a convex lens

The incident ray	The refracted ray	drawings
1. The ray that falls parallel to the principle axis	1. Passes through the focus	
2. The ray passing through the focus	2. Parallel to the principle axis	
3. The ray passing through the optical center	3. Passes without refraction	

The images formed by the convex lens:

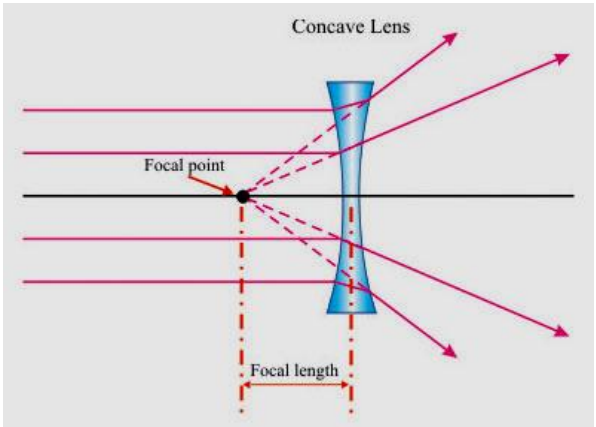
when an object is placed in front of the convex lens , the position & characteristics of the image formed can be determined by drawing 2 light rays & their refraction through the lens.

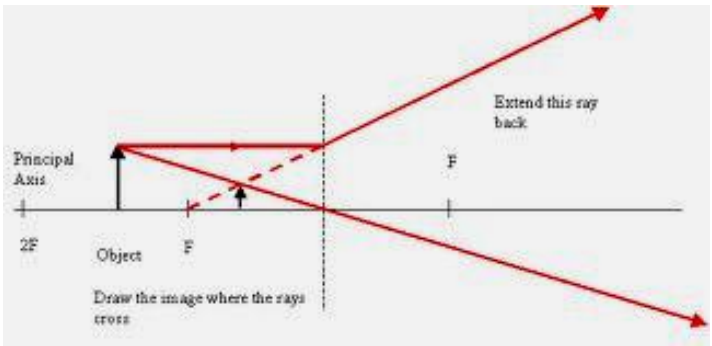
Position of the object	Position of the image	The properties of the image	Drawings
1. At a very large distance	At the focus	• Real • Very small	
2. At a distance more than the radius of curvature (i.e. more than double the focal length)	Between the focus & double the focal length	• Real • Inverted • Smaller than the object	
3. At the center of curvature (double the focal length)	At the center of curvature (double the focal length)	• Real • Inverted • Equal in size to the object	

4. Between Center C & the focus F (i.e. between the focus & double the focal length)	At a distance greater than the radius (i.e. double the focal length)	• Real • Inverted • Larger than the object	
5. At the focus	No image is formed		
6. At a distance less than the focal length	At the same side of the object (in front of the lens)	• Virtual • Upright • Enlarged = (magnified)	

A concave lens

- The focal length of the thick lens is smaller than the thin lens.
- Concave lens is a diverging lens because it diverges (scatters) rays passing through it.
- The extensions of the scattered light rays collect in a point which is considered as the **focus** of the concave lens in front of the lens.
- The focus of the concave lens is virtual because it can't be received on a screen.
- The image formed by a concave lens is always **<u>virtual, small & erect</u>**.



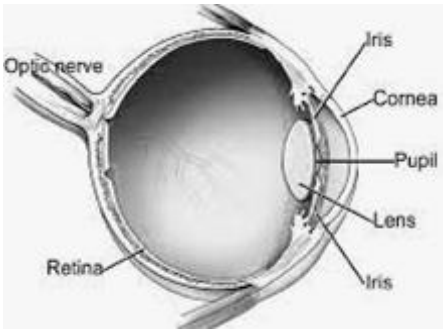


Comparison between the real focus & the virtual focus

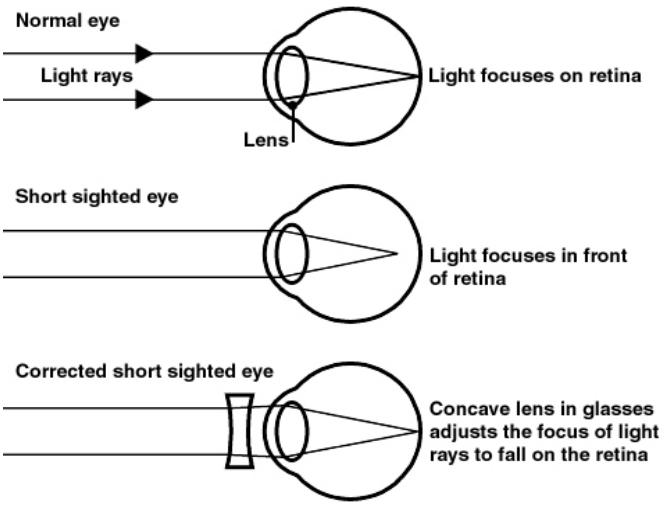
The real focus	The virtual focus
It's a principle focus formed from the intersection of refracted light rays.	It's a principle focus formed from the extension of refracted rays.
It's the focus of the convex lens	It's the focus of the concave lens

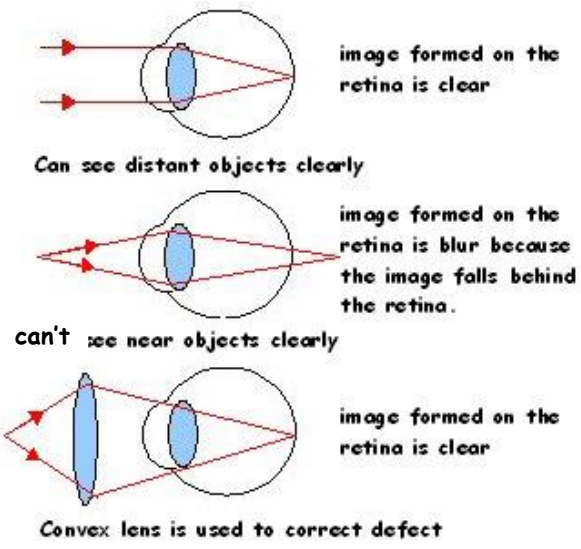
Vision Defects

Enriching information:
20/ 20 Eyesight is perfect . It means that the person can see a size twenty font letter from a twenty-foot distance (6 meters). These measurements are used in defining a person's vision.
To get a clear image of the object ,the least distance between the object & the eye should be 25 cm.



Short sight	Long sight
1. The Person can see near objects clearly and can't see far objects	The person can see far objects clearly and can't see near objects.
2. The image of far objects is formed in front of the retina.	The image of near objects is formed behind the retina.
3. What causes it? a. The diameter of the eyeball is too long. b. The curvature of convex lens is	What causes it? a. The diameter of the eyeball is too short. b. The curvature of convex lens is weak.
4. It is treated (corrected) by using Concave lens (diverging lens).	It is treated (corrected) by using convex lens (converging lens).





Contact lenses:

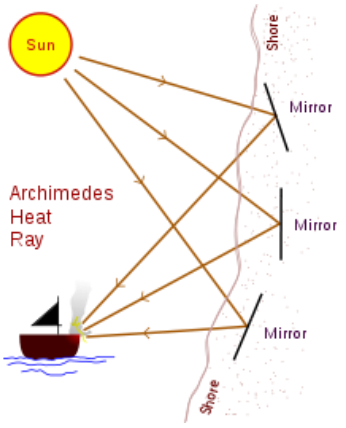
- They are used instead of glasses. These thin plastic lenses are applied & cover the cornea**.**
- They are cleaned by keeping them in an antimicrobial fluid.

Enriching Activities

Land surveying

- Land surveying accurately measures the three-dimensional position of land and distances to establish land maps and boundaries.
- Surveyors use a mirror & laser beam to measure distances & heights.
- Time needed for a light beam to hit a point & bounce back is calculated & used to determine distances.

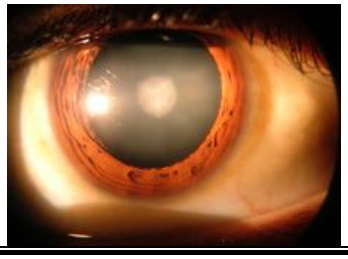
The Archimedes Heat Ray



- Archimedes may have used concave mirrors as a reflector to burn ships attacking sicily (in212 BC), Archimedes destroyed enemy ships with fire.
- The device, called the "Archimedes heat ray", was used to focus sunlight onto approaching ships, causing them to catch fire.

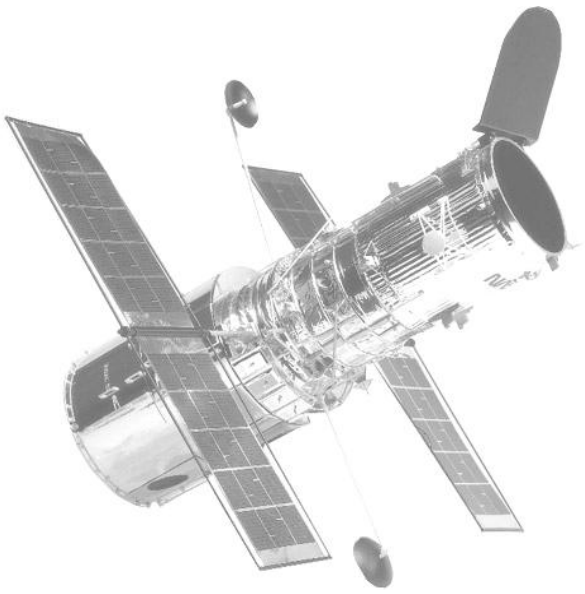
Cataract

- A cataract is a clouding in the lens of the eye, varying in degree from slight to complete opacity and preventing the passage of light.
- **Causes:**
  Cataracts develop for many reasons, including long-term exposure to ultraviolet light, side effects of drugs , effects of diseases such as diabetes, hypertension and old age.
- Genetic factors are a cause of cataracts and positive family history may have a role in someone getting cataracts at an earlier age.
- **Treatment**
  It's removed by surgery, by making a cut into the capsule of the cloudy lens in order to surgically remove the lens & transplant a plastic lens permanently in the eye to restore the eye sight..

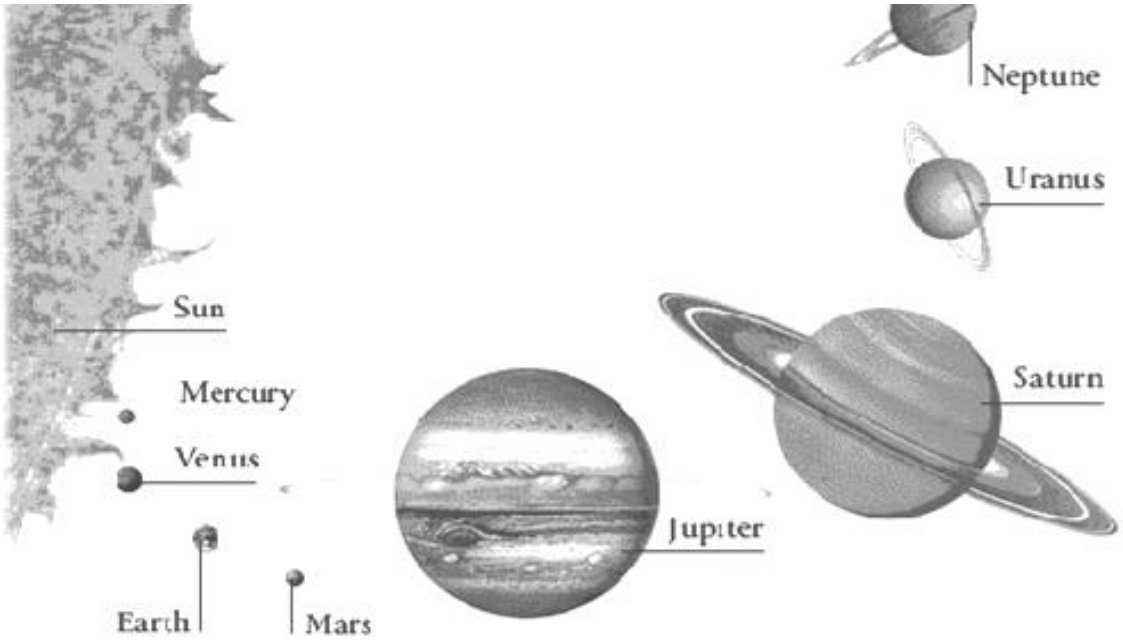


Unit 3: The Universe & the Solar System

Lesson 1: The Universe



Lesson 2: The Solar System



Lesson 1: **The Universe**

The Universe:

1. **Definition**: It's the wide space where the stars, galaxies, sun, planets & moons exist.
2. The **size** of the universe is so vast beyond comprehension.
3. The number of galaxies in the entire Universe is difficult to know for certain, since we can only see a fraction of the Universe, even with our most powerful instruments. The most current estimates that there are 100 to 200 billion galaxies in the Universe, each of which has hundreds of billions of stars.

The universe consists of a vast number of **galaxies**:

1. The **galaxy consists of** billions of stars which rotate together in space & are bound together by gravity.
2. Galaxies take different shapes according to how stars are organized & the harmony between them.
3. The galaxies gather together in clusters.

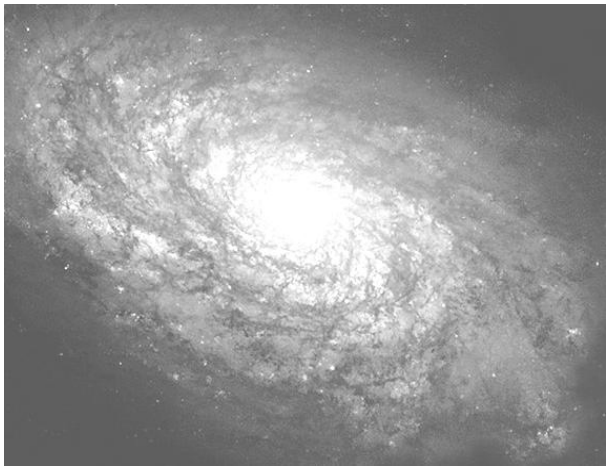
Enriching information:

The light year measures distances in space.

1 Light year is the distance covered by light in one year.

Distance covered by light in 1 year = speed of light x t

1 light year = 300,000 km/s x (1x 365x 24 x 60x 60) = 946,000 million km

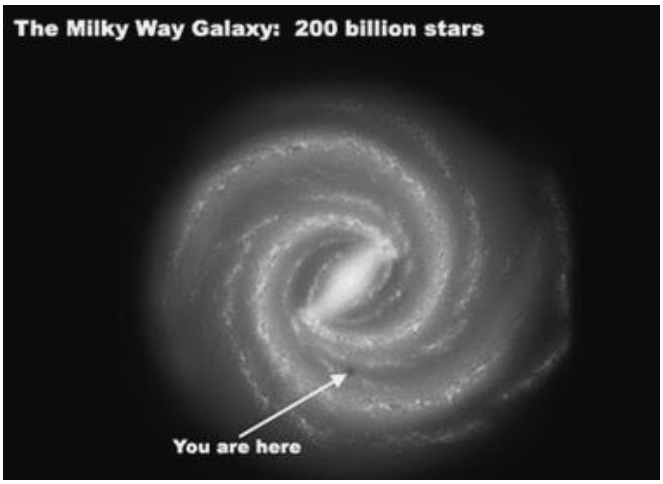


Spiral galaxy

The Milky Way

1. We live in one of the arms of a large **spiral galaxy** called the Milky Way. The Sun and its planets (including Earth) lie in one of the spiral arms of the galaxy, about half way out from the centre.
2. The Milky Way is shaped like a huge whirlpool that completes one rotates around the center of the galaxy rotates once every 200 million years. It is made up of at least 100 billion stars, as well as dust and gas. It is so big that light takes 100 ,000 years to cross from one side of the galaxy to the other.

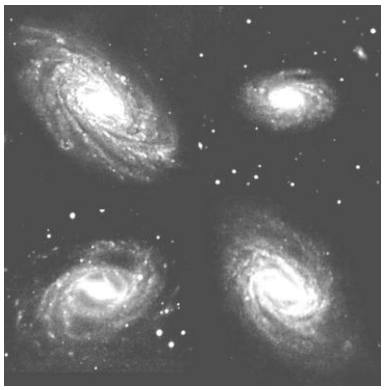
Structure: Old stars gather in the center of the galaxy surrounded by smaller stars**.**



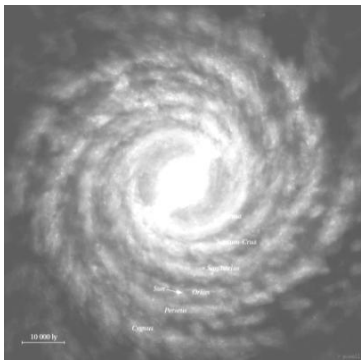
The Milky Way viewed from the mountains.
The name Milky Way refers to the milky patch of sky.

The Solar System

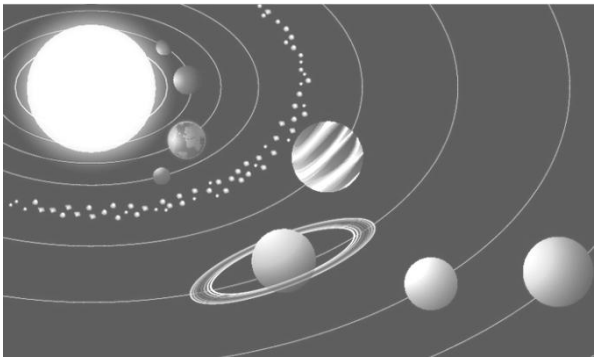
The Universe



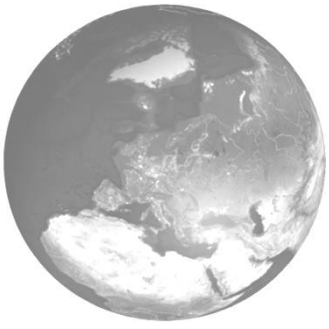
Galaxies: each is a group of billions of stars



Milky Way Galaxy: where the solar system exists



The solar system = The sun & 8 planets



Earth: The planet where we live

(أَوَ لَمْ يَرَ الذينَ كَفَرُوا أَنَّ السَّمَاوَاتِ و الأَرْضَ كَانَتَا رَتْقًا فَفَتَقْنَاهُمَا و جَعَلْنَا مِنَ المَاءِ كُلَّ شَيْءٍ حَيٍ أَفَلَا يُؤْمِنُونَ)

الآية 30 سورة الأنبياء

The Big Bang Theory:

- Discoveries in physics & astronomy lead scientists to explain how the universe started & evolved (changed over time).
- The big bang theory explains how the universe was formed. This theory was formulated in 1933 to explain the origin of the universe.
- The history of the universe according to The Big Bang Theory:

1. Most astronomers believe the Universe began in a Big Bang about 15 billion years ago. At that time, the entire Universe was smaller than a pinhead. It was very hot & dense. Matter was a gaseous ball of high pressure & high temperature in a small volume.

2.An explosion suddenly took place. The Universe that we know was born. In a fraction of a second, the Universe grew from smaller than a pinhead to bigger than a galaxy. And it kept on growing at a fantastic rate. It is still expanding today.

3. As the Universe expanded and cooled, atomic particles merged together producing helium & hydrogen, which over time produced stars, galaxies & the universe as we know.

{إِنَّ رَبَّكُمُ اللّهُ الّذِي خَلَقَ السَّمَاوَاتِ وَالأَرْضَ فِي سِتَّةِ أَيَّامٍ ثُمَّ اسْتَوَى عَلَى الْعَرْشِ يُغْشِي اللَّيْلَ النَّهَارَ يَطْلُبُهُ حَثِيثًا وَالشَّمْسَ وَالْقَمَرَ وَالنُّجُومَ مُسَخَّرَاتٍ بِأَمْرِهِ أَلاَ لَهُ الْخَلْقُ وَالأَمْرُ تَبَارَكَ اللّهُ رَبُّ الْعَالَمِينَ} الأعراف:54.

Enriching information

In 1964 a scientist detected a noise coming from space by a special device. This radio wave signal was picked accidently. This signal was explained to have come from the universe at the moment of the big bang & the noise the scientists heard was the echo of the Big Bang. T.V sets receive this signal when the satellite transmission is turned off.

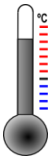
In 1992, a spacecraft detected a difference in radiation which was attributed to the Big Bang. This was considered as evidence that supports the Big Bang Theorv.

The big bang took place through 5 stages:

1.The great explosion **2. Galaxy formation**
3. Star & the solar system formation **4. Life appeared on earth**
5.Recent stage

<u>Explain how the universe evolved according to the Big Bang theory</u>

At the beginning of the universe 15 billion years ago, it had homogenous (uniform) density but as matter expanded, masses of matter merged together forming larger masses & density increased. Gravity pulled more matter towards the dense masses forming ancestral galaxies with spaces between them.

Time starting with the Big Bang	**Events which took place**
Few minutes after the Big Bang 	❖ A rapid sudden explosion caused the gaseous ball to expand. ❖ Few minutes after the big bang , the protons and neutrons came together, forming hydrogen and helium nuclei.  ❖ As the Universe cooled to about 10,000 degrees. Atomic nuclei formed atoms. ❖ The nuclei of hydrogen merged together to form helium.The Universe was filled with clouds of hydrogen and helium gas. ❖ Hydrogen formed 75% & Helium formed 25% of the matter of the universe.
1000 million = billion years after the big bang	❖ Primary gas clouds fused (joined) to form homogenous small clouds which formed galaxies.
2-3 billion years after The big Bang	❖ Ancestral galaxies evolved
After 3 billion years	❖ Galaxies began to form
5 billion years	❖ Our galaxy, the Milky Way was born & took a disc form.
10 billion years after the Big Bang	❖ Formation of the solar system: The Sun & the planets.
12 billion years after the Big Bang	❖ Living organisms appeared on earth.
15 billion years after the Big Bang	❖ Recently The earth took shape as we know today

آيات سيدنا إبراهيم مع قومه

(فَلَمَّا جَنَّ عَلَيْهِ اللَّيْلُ رَأَى كَوْكَبًا قَالَ هَذَا رَبِّي فَلَمَّا أَفَلَ قَالَ لا أُحِبُّ الآفِلِينَ (76) فَلَمَّا رَأَى الْقَمَرَ بَازِغًا قَالَ هَذَا رَبِّي فَلَمَّا أَفَلَ قَالَ لَئِنْ لَمْ يَهْدِنِي رَبِّي لأَكُونَنَّ مِنْ الْقَوْمِ الضَّالِّينَ(77) فَلَمَّا رَأَى الشَّمْسَ بَازِغَةً قَالَ هَذَا رَبِّي هَذَا أَكْبَرُ فَلَمَّا أَفَلَتْ قَالَ يَا قَوْمِ إِنِّي بَرِيءٌ مِمَّا تُشْرِكُونَ(78)إِنِّي وَجَّهْتُ وَجْهِي لِلَّذِي فَطَرَ السَّمَاوَاتِ وَالأَرْضَ حَنِيفًا وَمَا أَنَا مِنْ الْمُشْرِكِينَ(79) الأنعام.

Cosmogony in ancient times:

(Cosmogony is any theory concerning the origin of the universe)

Ancient Civilization	Their views of cosmology (the science that studies celestial bodies)
1. Stone age	Myth dominated the human mind
2. Ancient Egyptians & Babylonians	They thought that the eternal universe was controlled by many gods.
3. Greeks & Romans	They were the first to see celestial events were subjected to human investigation & developed
4. Indian & Chinese	They studied astrology & thought that the knowledge about stars was used to determine the behavior of people & events in their life.
Generally speaking , old civilizations thought that heaven (the skies) were governed by rules of multiple gods & they didn't attempt to explain the astronomical phenomena on scientific basis.	
5. Islamic civilization	Muslims built observatories to observe & study the stars & take accurate measurements of movements of

This device was used to find the direction of Kaaba using the positions of stars in the sky.

An Activity
Purpose : To show you how the universe is expanding.
Materials: A cup of flour , a tea spoon of bread yeast , a small cup of warm water & bowl to form a dough in & a table spoon filled with raisins.
Steps:
1. Add the yeast to the warm water & sugar & allow it to expand.
2. Mix the flour with the yeast & make a dough then put the raisins on the surface of the dough.
3. Leave the dough in a warm place to ferment.

Observation:
As the dough ferments , it expands & the distances between the raisins increase.
Conclusion:
This model shows how the universe is expanding & the galaxies are moving apart.

1

2

3

4

The future of the universe
Two theories explain what's going to happen to the universe.

The open theory predicts that the universe will keep expanding endlessly.

The closed theory predicts that the universe will eventually stop expanding then it will contract until it becomes so compact & hot & then a new big bang might happen.

Lesson 2 : The Solar System

In the past people thought that the Earth was the centre of the universe but modern science proved that the sun is the center of the solar system which is a tiny part in the universe.

- **The solar system consists of :**
  - The sun
  - Eight planets which revolve around the sun.
  - Moons which revolve around planets
  - Asteroids
  - Comets

A comet

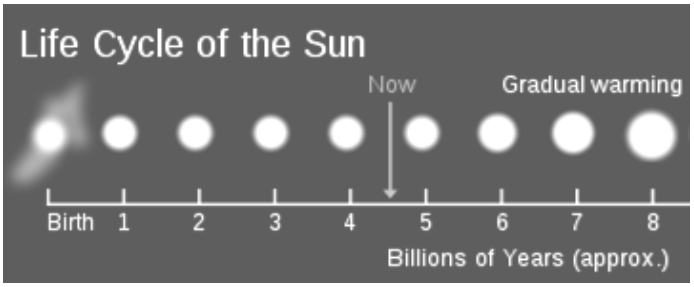
- The solar system extends 12 billion km in space.
- The solar system was formed 4600 million years ago , from a giant cloud of gases (called nebula) which gave birth to the sun. Some matter separated from the nebula & formed the planets.

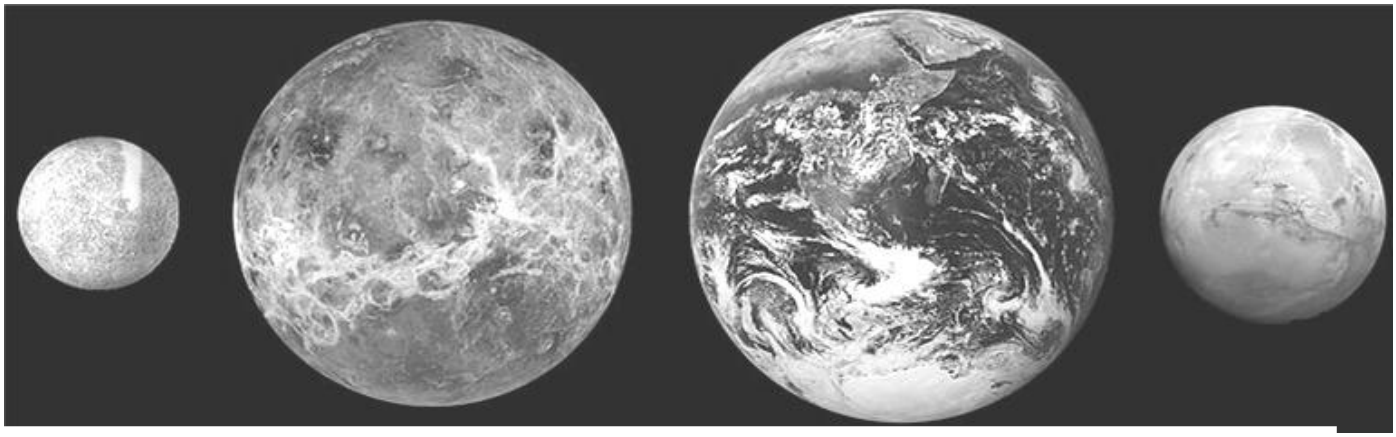
The Sun

- is the star in the center of the solar system.
- contains 99% of the mass of the solar system.

Enriching information

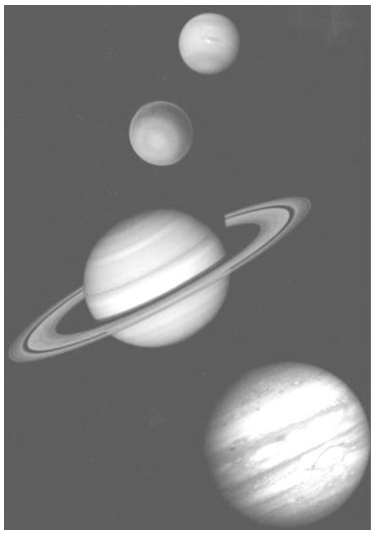
The sun is 4.6 billion years old & it will continue burning for 4.6 billion years.





The inner planets

Mercury **Venus** **Earth** **Mars**



From top to bottom:

Neptune

Uranus

Saturn

Jupiter

What's a nebula?

- A nebula is a cloud of gas and dust in space. Some nebulas are regions where new stars are being formed, while others are the remains of dead stars.

A nebula

The Recent Theory explains how the solar system was formed :

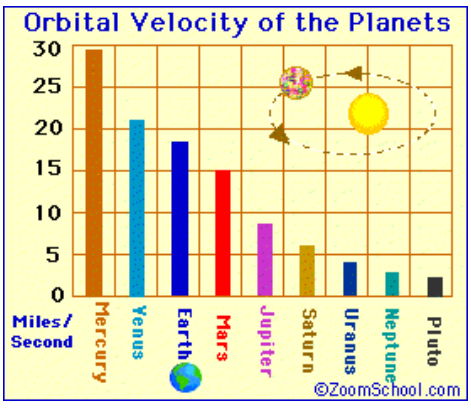
- Our solar system started as a giant, spinning, cloud of gas and dust made of rocks & ice that slowly collapsed under its own gravity. This cloud of gas is called the **solar nebula.**
- As its spin increased the nebula flattened . Most of the material collected in the center of this cloud and eventually formed the sun.
- The rest of the nebula formed the planets.
- The dust compressed in the internal zone of the sun forming the inner planets (Mercury, Venus , Earth & Mars).
- The dust & gases compressed in the external zone of the sun formed the outer planets (Jupiter , Saturn , Uranus & Neptune).

The role of gravity in the formation of the solar system

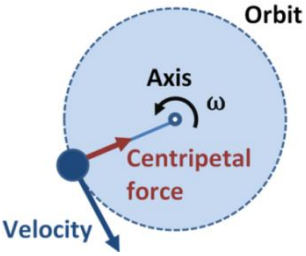
1. During the formation of the solar system, the gravity of the growing matter in the center pulled the particles to the center. This shaped the cloud into a sphere which became the sun.
2. Smaller clumps of matter became planets, moons, asteroids and comets
3. Gravity is the force of attraction which keeps the planets revolving in their orbits.
4. A planet with strong gravity attracts an envelope of gases which rotates around the planet (an example is the Earth which is surrounded by an atmosphere due to its strong gravity.)
5. In the 17th century ,English physicist Newton observed the motion of the planets & the moon & concluded the following law:

The Universal Law of Gravitation
Every two objects in the Universe attract every other object with a force that is directly proportional to the product of their masses & inversely proportional to the square of the distance between them.

Enriching Information:
The Average Orbital Speed of the Planets
As the planets orbit the Sun,they travel at different speeds. Each planet speeds up when it is nearer to the Sun and travels more slowly when it is far from the Sun.



Enriching Information:
The **centripetal force** is the force that causes an object to move in a circle, acting towards the centre of the circle. In the case of a planet or the moon, the centripetal force is gravity.



قال تعالى :(أَوَلَيْسَ الَّذِي خَلَقَ السَّمَاوَاتِ وَالْأَرْضَ بِقَادِرٍ عَلَى أَنْ يَخْلُقَ مِثْلَهُم بَلَى وَهُوَ الْخَلَّاقُ الْعَلِيمُ (81) إِنَّمَا أَمْرُهُ إِذَا أَرَادَ شَيْئاً أَنْ يَقُولَ لَهُ كُنْ فَيَكُونُ (82) فَسُبْحَانَ الَّذِي بِيَدِهِ مَلَكُوتُ كُلِّ شَيْءٍ وَإِلَيْهِ تُرْجَعُونَ) يس من الاية 81 الى 83

The theories which explain the evolution of the solar system

- 20 theories explain the evolution of the solar system.
- These theories aren't proven & they are changed all the time.
- You'll study the most important theories which are:

Nebular assumption
by Laplace
Developed in 1796

The crossing star theory
by Chamberlain & Molten
Developed in 1905

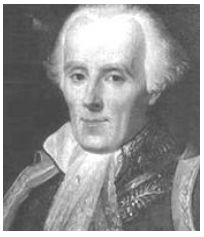
The modern theory of the world
By Alfred Hale
Developed in 1944

1. Nebular assumption by Laplace

- The French scientist Laplace published a research called **World Order.**
- His theory was based on 2 observations:

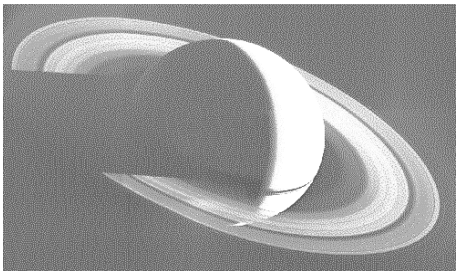
a. The cloud of gas called nebula seen in the sky.

b. The cloudy rings which surround some planets such as the rings around Saturn.

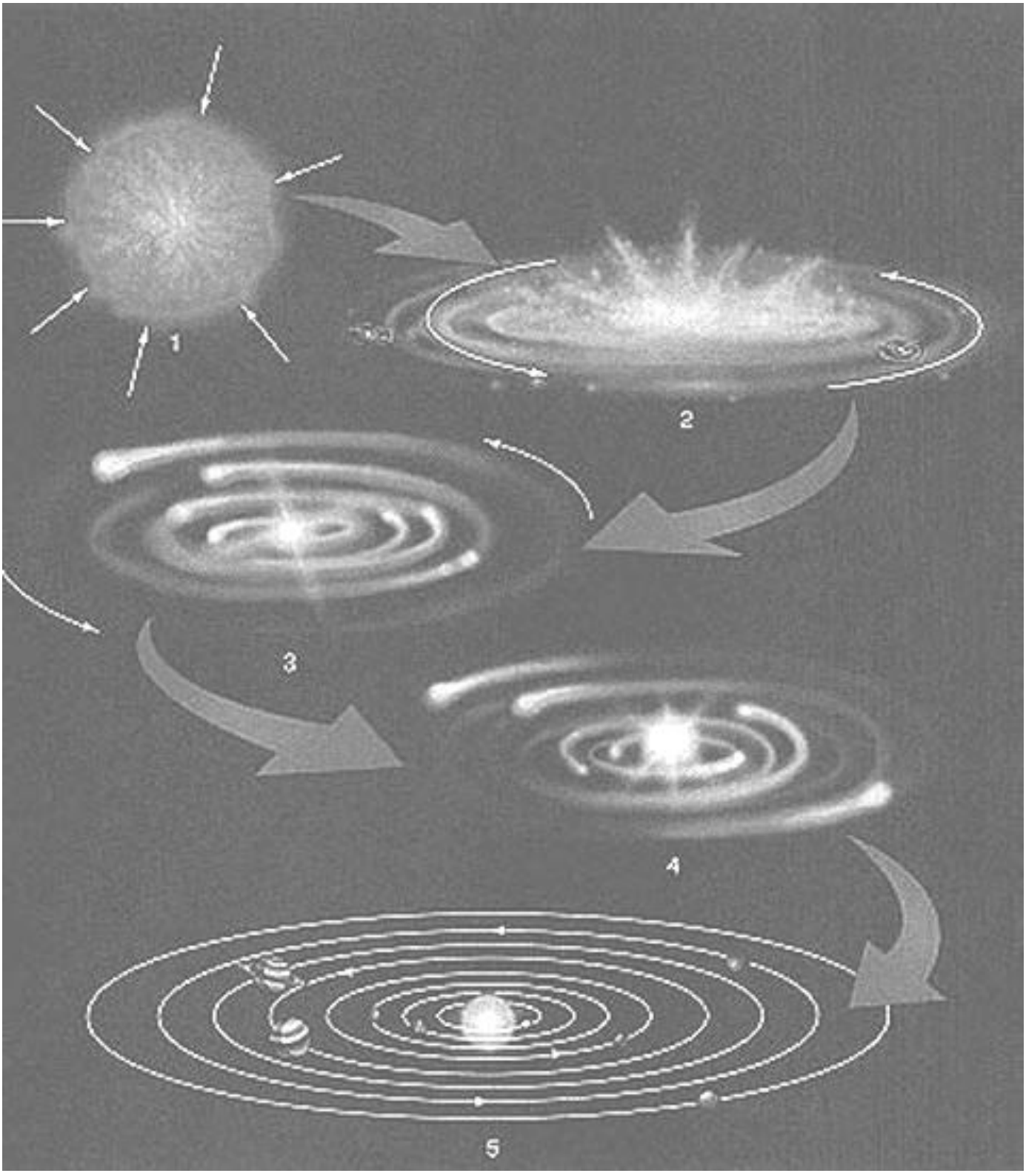


- The solar system developed as follows:

1. A nebula of glowing gases revolved around itself.
2. Over time the nebula cooled gradually.
3. The gases concentrated & the size of the nebula **decreased** & its speed of rotation around itself **increased**. The nebula took a spherical shape.
4. The centrifugal force resulting during rotation caused the nebula to change its shape into a **flat disk**.
5. The flaming mass in the center of the nebula became the **sun**.
6. The centrifugal force also caused the separation of parts of the nebula. These parts kept rotating in the same direction of the original nebula , then cooled , solidified & evolved into planets.

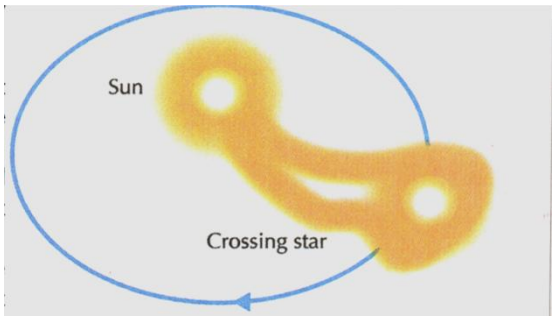


Nebular assumption by Laplace



2. The crossing star theory by Chamberlain & Molten 1905

1. At the beginning , the sun existed without the planets.
2. Another huge star was attracted to the sun.
3. The part of the sun facing the other star **expanded.**
4. This led to a huge explosion in the sun which formed a gaseous line of a great length covering a large distance in space.
5. The gaseous line cooled & condensed due to attraction forces forming the planets.
6. The explosion caused the sun to move away from the other star.

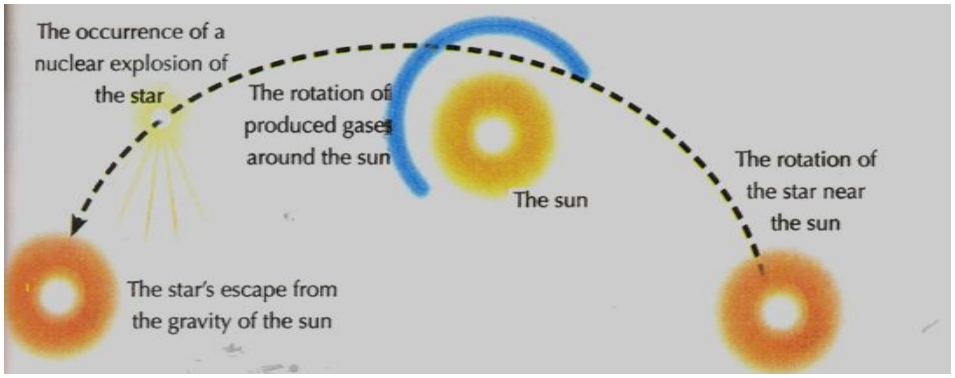


3. The modern theory of the world by Alfred Hale1944

The theory is based on the following observations:
a. A star glows for a short time & its glow exceeds any other star in the sky.
b. A day or two later the excess glow produced by this star is reduced & the star glows as any other star.
One explanation for this phenomenon could be huge nuclear explosions taking place on the surface which produce a huge amount of heat & light & show as glowing, & when the nuclear explosions stop, the glow of the star is reduced back to usual.

Alfred Hale used these observations to develop a theory which explains how the solar system evolved.
He assumed:

1. A star that existed long ago rotated near the sun.
2. Huge nuclear reactions in this star caused the explosion of the star.
3. The force of the explosion pushed the other star away from the sun.
4. A cloud of gas remained, cooled & contracted forming planets.
5. The sun attracted the planets by the force of gravity & kept them revolving in their orbits.

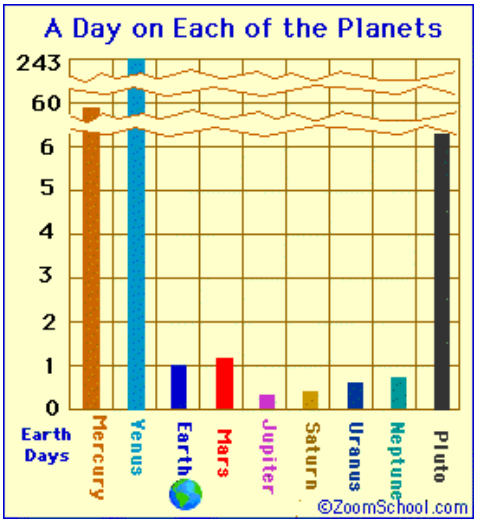


A day on each planet

- A day is the time that it takes a planet to rotate on its axis one complete rotation. A day on Earth takes almost 24 hours. The earth completes one rotation around its axis in 1 Earth day.
- The planet with the longest day is Venus; a day on Venus = 243 Earth days. (A day on Venus is longer than its year; a year on Venus takes only 224.7 Earth days).
- The planet with the shortest day is Jupiter; a day on Jupiter only takes 9.8 Earth hours! When you observe Jupiter from Earth, you can see some of its features change.
- A day on each planet has a different length because of:

  a. the radius of the planet.

  b. The speed of the planet as it rotates around its axis.



- **A planetary year is the time the planet takes to complete one cycle around the sun.**
- The length of a year is different from a planet to another according to:

  a. The distance between the planet & the sun.

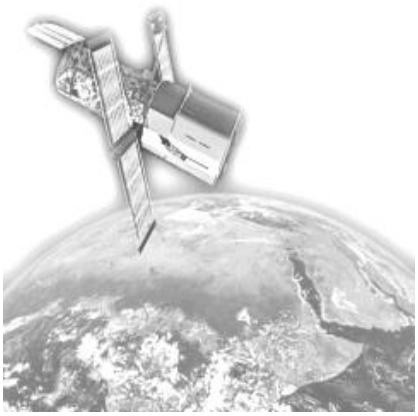
  b. The speed of the planet during its revolution around the sun.

- **Mercury** has the shortest year because it's the nearest planet to the sun.
- **Neptune** has the longest year because it's the furthest planet from the sun.

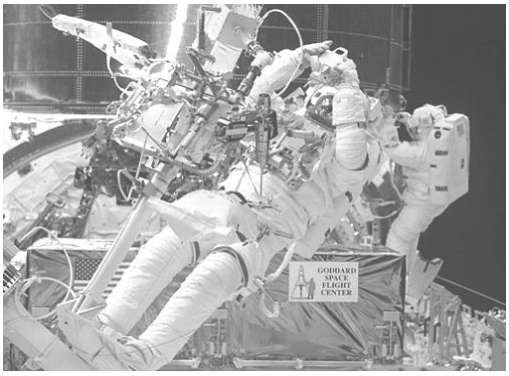
Planet	Period of Rotation (1 planetary day)	Period of Revolution Around the Sun (1 planetary year)
Mercury	59 Earth days	0.24 Earth years
Venus	243 Earth days	0.62 Earth years
Earth	1	1
Mars	1.03 Earth days	1.9 Earth years
Jupiter	0.41 Earth day	12 Earth years
Saturn	0.43 Earth day	29 Earth years
Uranus	0.72 Earth day	84 Earth years
Neptune	0.67 Earth day	165 Earth years

Technological Application

The Hubble telescope



1. The Hubble telescope was launched by space shuttle Discovery in April 1990 .
2. It rotates around the earth at a height of 500 km.
3. It collects photos of the universe as it was a long time ago.
4. By analyzing the photos sent by Hubble Telescope , astronomers concluded what happened to the universe since the Big Bang.
5. The space shuttle is launched to maintain & upgrade the equipment in the telescope.

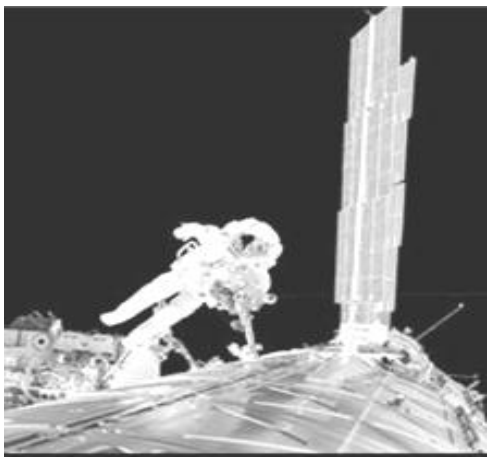


Astronauts are servicing Hubble.

This Hubble photo is of one of the largest-seen star-birth regions in the galaxy, the Carina Nebula.

Space suits

- In the past the astronauts used to wear the same space suit during their trip in space.
- Today , astronauts wear various types of clothing for all aspects of a mission to space. Whether working inside the space shuttle or the space station, working outside in space, astronauts wear the proper clothes for both comfort and protection.



An astronaut works at a computer station aboard the Earth-orbiting Interntional Space Station.

Gravity & weightlessness

The weight of an object is the force of gravity on the object.

When astronauts are in orbit, that gravity is the only force acting on them so they are freely falling around the Earth. Hence they are weightless.

Experiments are performed on animals & plants in space to study the state of weightlessness.

Orbiting Earth

Once a spacecraft reaches orbit, everything inside it appears to be weightless. Anything (or anyone) that is not tied down will float.

Solar telescope

- Telescopes on earth or telescopes carried in space gather images of the sun to study what happens on its surface.
- Spacecrafts are sent in trips to other planets. The spacecrafts can land on other planets or orbit them & send photographs to computers stationed on the Earth.
- Sunlight (spectrum) is analyzed by a device called spectrometer which reveals the wavelength of sun radiation. These studies give information about the sun.
- A solar telescope reflects sun rays towards a mirror which forms an image of the sun to be analyzed & explain phenomena taking place on the sun surface.

Solar telescope

Unit 4: Reproduction & the continuity of species

Lesson 1:Cell division

Lesson 2: Asexual & sexual reproduction

A sweet potato tuber growing into a new plant.

(وَلَقَدْ خَلَقْنَا الإِنسَانَ مِن سُلالَةٍ مِّن طِينٍ ثُمَّ جَعَلْنَاهُ نُطْفَةً فِي قَرَارٍ مَّكِينٍ ثُمَّ خَلَقْنَا النُّطْفَةَ عَلَقَةً فَخَلَقْنَا الْعَلَقَةَ مُضْغَةً فَخَلَقْنَا الْمُضْغَةَ عِظَامًا فَكَسَوْنَا الْعِظَامَ لَحْمًا ثُمَّ أَنشَأْنَاهُ خَلْقًا آخَرَ فَتَبَارَكَ اللَّهُ أَحْسَنُ الْخَالِقِينَ) الآيات 12 – 14 سورة المؤمنون

Unit Preview

- The purpose of the process of reproduction is the continuity of the species.
- **All organisms with similar shape which can reproduce & give birth of fertile animals form a group called species.**
- Reproduction involves cell division.

- Cell division occurs via 2 mechanisms:

  a. **Mitosis** which increases the number of cells.

  b. **Meiosis** which produces cells with half the number of chromosomes. The cells resulting from this type of cell division are called **gametes**.

- Methods of reproduction:

  a. Asexual reproduction which occurs in one celled organisms such as bacteria as well as plants. The offspring is identical to the parent.

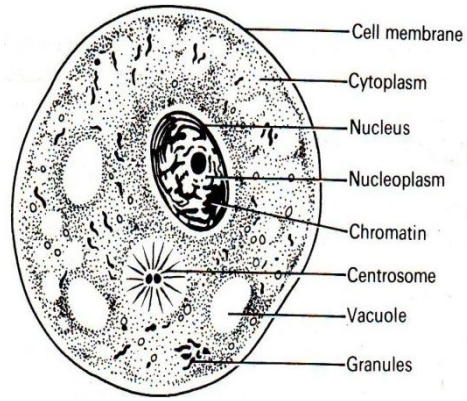
  b. Sexual reproduction which occurs in multicellular organisms involves 2 parents (male & female) & the offspring is different from the parents therefore this type of reproduction is a source of genetic variation.

A bacterium cell divides into 2 new cells.

Living organisms are either:

Unicellular: They consist of one cell.
Examples:
Ameoba & bacteria

Multicellular: They consist of several cells.
Examples:
Plants , animals & humans

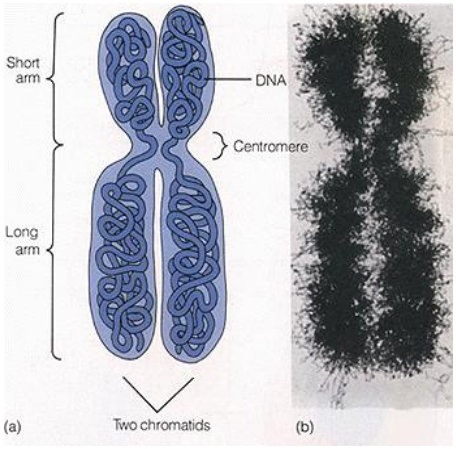


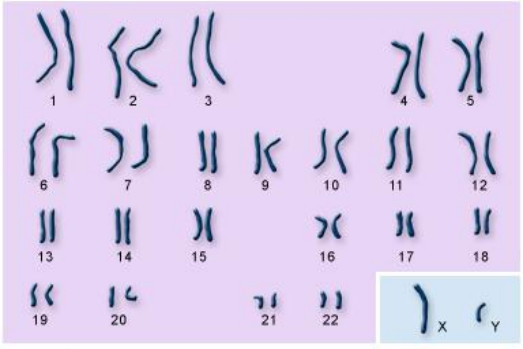
The building unit of living organisms is the cell.

The nucleus of the cell contains the hereditary substance which is responsible for transmitting the characteristics of the cell to the daughter cells during cell division. The hereditary substance is also called the chromosomes.

The structure of the Chromosome (hereditary or genetic material):

- Two rod –like structures called **chromatids** connected together by the **centromere**.
- The chemical composition of the chromosomes is nucleic acid called DNA.
- DNA carries the genetic traits of the organism.
- Chromosomes have an important role in cell division.
- Each species has a specific number of chromosomes which differs from any other species. (Humans have 46 chromosomes while cats have 38 chromosomes).

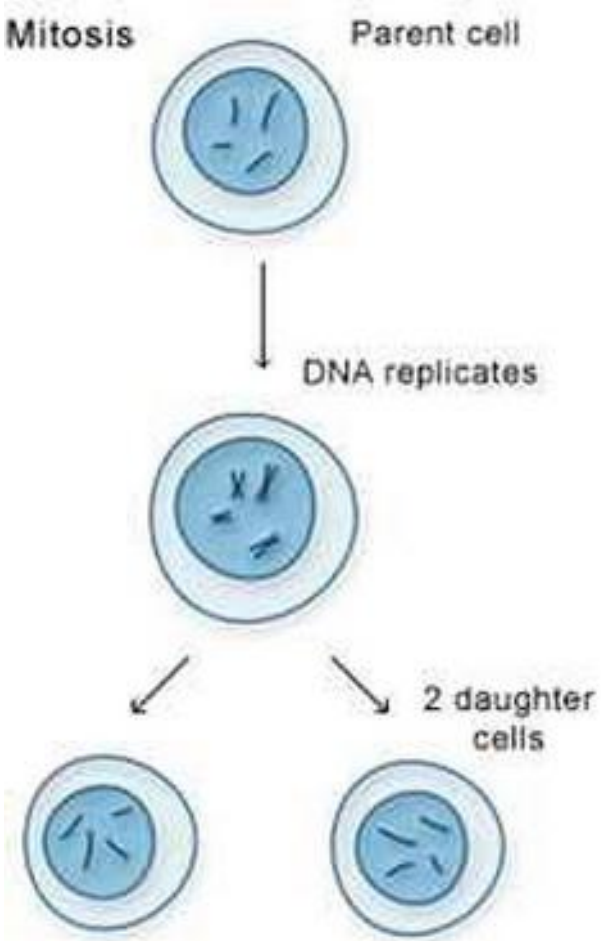


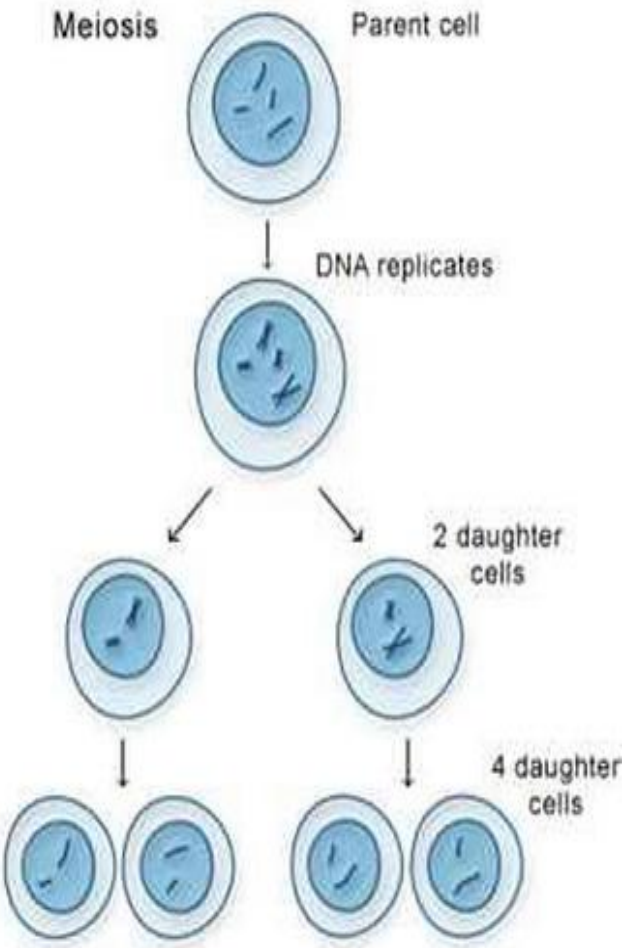


Humans have 23 pairs of chromosomes in each somatic cell.

Compare somatic cells &reproductive cells:

Points of comparison	Somatic cells	reproductive cells
Their location in the body	1. All body cells except the reproductive cells in the reproductive system Examples: muscles & skin. 2. Plant root, stem & leaves.	1.In the gonads of humans (testes & ovaries)which are responsible. 2. Pollen grains & ovules in plants
Number of chromosomes	2n (Diploid)	Half the number of chromosomes n (haploid)
Cell division which they undergo	Mitosis	Meiosis
Purpose of cell division	Increase the number of cells needed for: - growth - Compensating dead cells (during illness or trauma)	The formation of male gametes (sperms) in males & the formation of female gametes (ova) in females. Fusion of a male gamete with a female gamete produces the zygote (offspring) which carries the genetic material of both parents & therefore has combined traits from both parents.

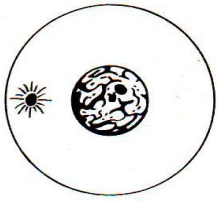

Mitosis
Parent cell
DNA replicates
2 daughter cells


Meiosis
Parent cell
DNA replicates
2 daughter cells
4 daughter cells

Phases of mitosis

There are several phases in the process of cell division by mitosis. The period during which cells are not dividing is called the **interphase.**

During interphase , the cell is prepared for cell division & DNA is duplicated.



1-Prophase:

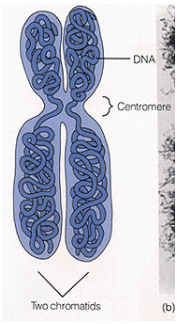
In animals cells:

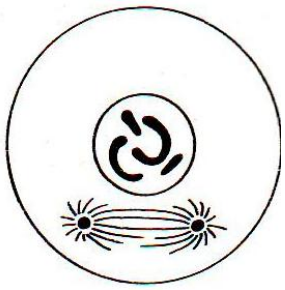
- A network of fibers called spindle fibers appear in the cytoplasm.
- The centrosome separates into two particles which migrate to opposite poles of the cell, but remain attached by fine thread-like spindles.

In plant cells:

- The cytoplasm at the cell poles condenses forming spindle fibers since plant cells don't contain centrosomes.
- The chromatin becomes concentrated and forms dark thread-like structures called **chromosomes.**

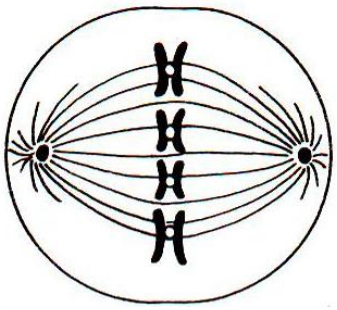
- Each chromosome consists of two identical daughter chromosomes, called **chromatids**, which are held together at the middle by a **centromere.**
- The nuclear membrane & the nucleolus disappear.





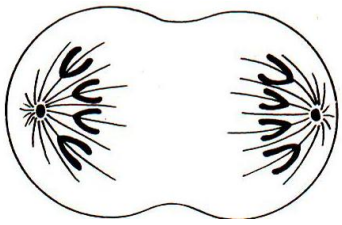
2-Metaphase:

- **The chromosomes arrange** themselves at the centre of the cell (**middle**) and are attached to the spindles of the centrosome at the opposite poles of the cell.
- The centromeres lie on the equatorial plate.



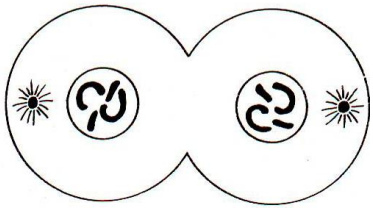
3-Anaphase:

- The centromere divides lengthwise & the chromatids in each chromosome separate.
- Spindle fibers shrink and the two identical chromatids move apart still attached to the spindles.
- Each group of chromatids migrates towards one of the opposite poles of the cell.
- At the end of the stage the spindles break.

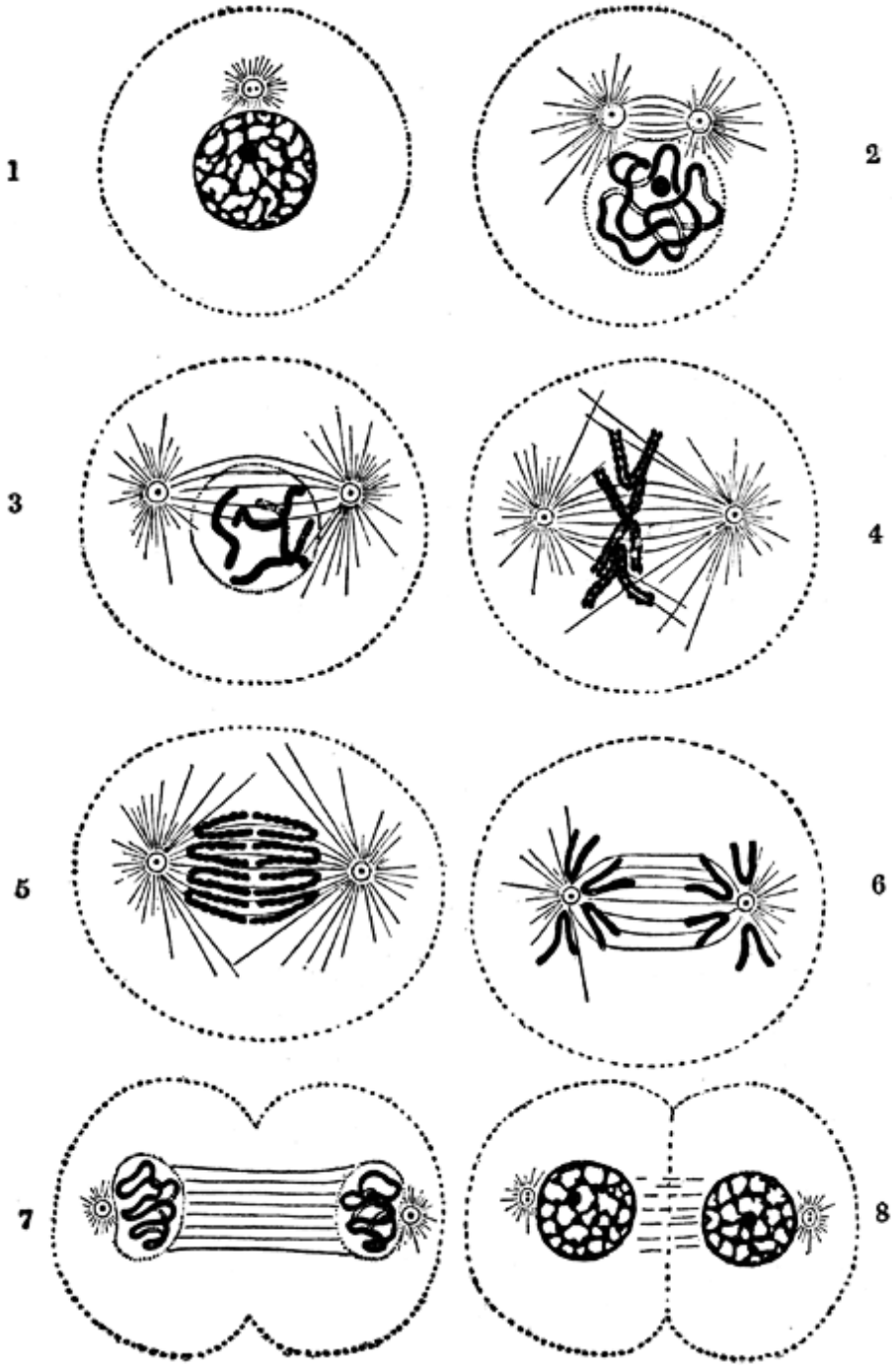


4-Telophase:

- Nuclear membranes enclose the two groups of chromosomes.
- the spindles disappear
- A constriction develops around the middle of the cell forming two identical cells where each cell has a complete set of chromosomes (2n).



Phases of mitosis



Phases of Meiosis

- ❖ Meiosis occur in organisms which reproduce sexually.
- ❖ Meiosis produces gametes needed for sexual reproduction (which occurs between 2 parents: male & female).
- ❖ In flowering plants , meiosis occur in the anther to form pollen grains & in the ovaries to form ovules(eggs).
- ❖ Meiosis reduces the number of chromosomes.
- ❖ Meiosis occurs through **2 consecutive** stages: **Meiosis I & Meiosis II**
- ❖ The chromosomes are duplicated in the interphase before the ^{1st} meiotic division.

The first meiotic division: (Meiosis I)

1-Prophase I

a. The chromatin reticulum intensifies, the chromosomes become distinct.

b. **Homologous chromosomes**

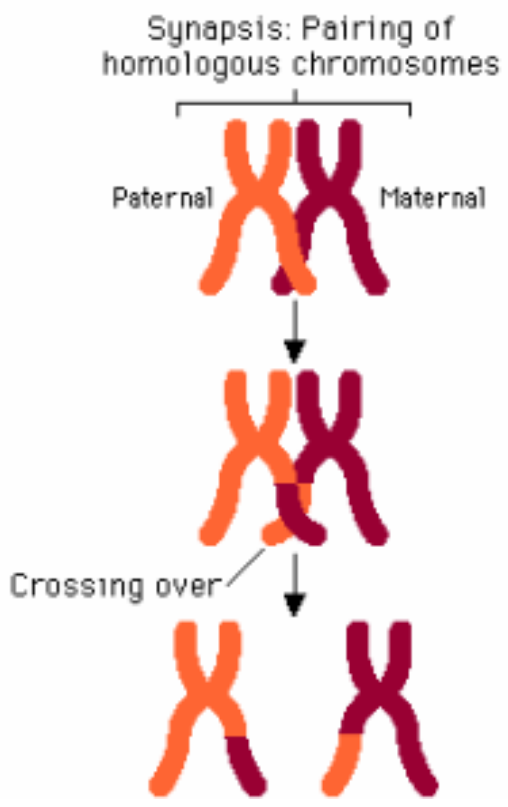
(Two chromosomes similarly shaped and carry the same type of genes) arrange in pairs each pair appears formed of four even chromatids called a **tetrad.**

c. Centrioles (in animal cells) divide near the end of this phase.

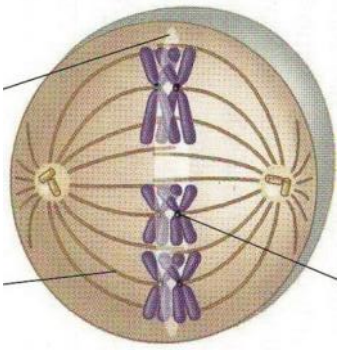
d. Spindle fibers appear.

e. Nucleolus and nuclear membrane disappear.

f. **Crossing over** occurs between two inner chromatids of the tetrads where the chromatids exchange parts & this results in **genetic variation** among the individuals of the species.

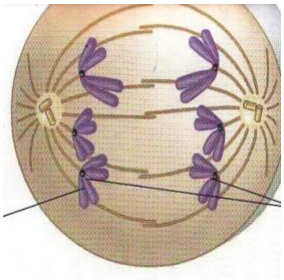


2. Metaphase I :



The pair of homologous chromosomes
move into position on the equatorial plane of the cell.

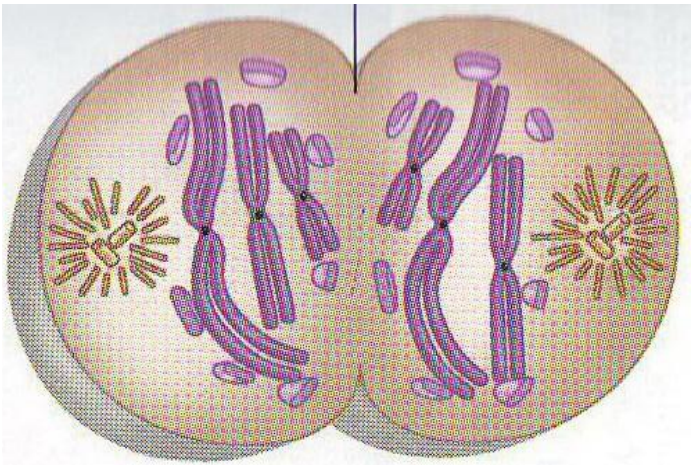
3. Anaphase I :



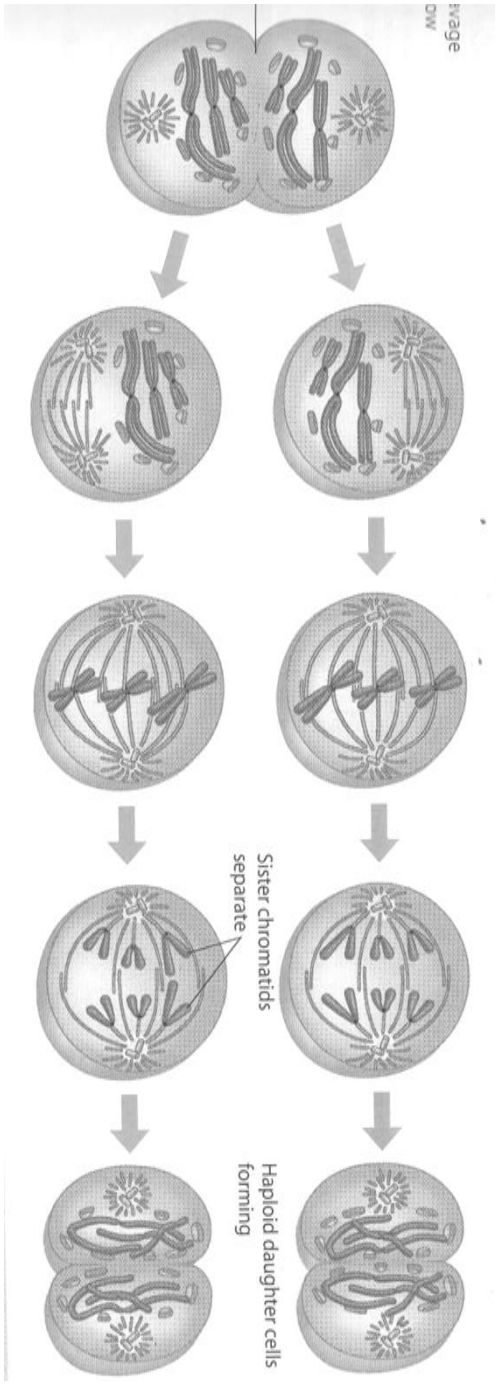
- Homologous chromosomes separate as the spindle fibers shrink.
- 1 of each pair of chromosomes migrate towards each cell pole.
- During this stage the reduction from diploid to haploid occurs.

4. Telophase I :

- Telophase I consists of changes that
  return the cell to an interphase condition.
- The chromosomes uncoil.
- the nuclear membrane re-forms around the chromatin material , the nucleoli reappear.
- The cytoplasm divides, producing two separate cells each has half the number of chromosomes of the parent cell.



The second meiotic division : (Meiosis II)

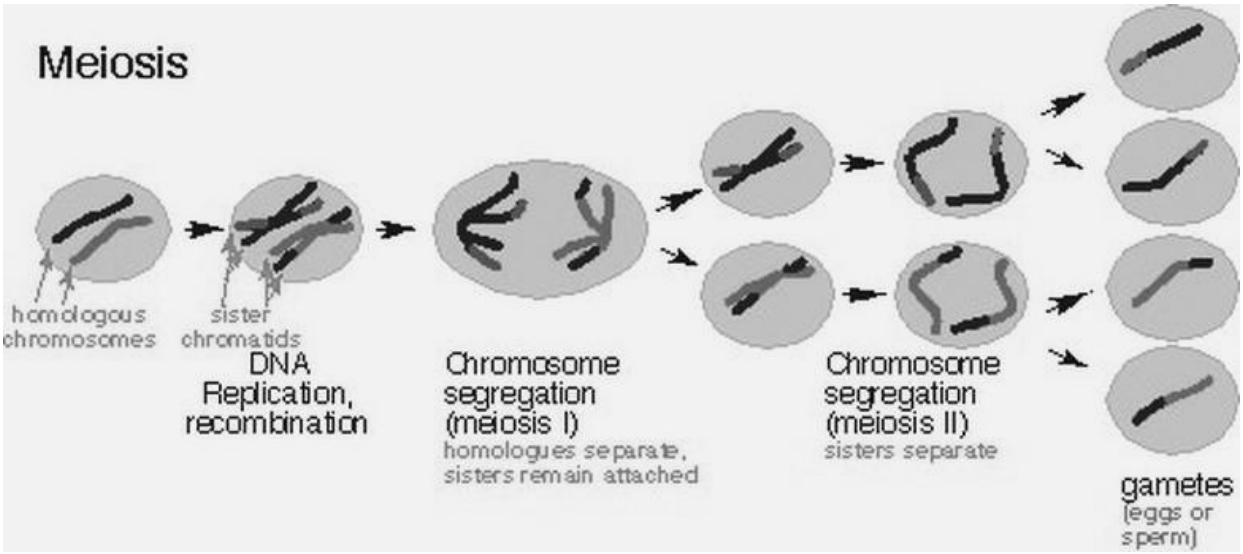


- This division takes place in both of the daughter cells formed during meiosis I.
- It's similar to mitosis.
- During **Metaphase II,** the chromosomes arrange on the equator of the cell.Then the centromere divides so that each one connects with a chromatid on the spindle.
- During **Anaphase II,** each of the chromatids within the chromosome separate and move independently towards one of the cell pole.
- At the end of meiosis II, four haploid cells are formed .
- These haploid cells are the gametes.

Can you explain why gametes are produced by meiosis?

Meiosis reduces the number of chromosomes.

Fusion of haploid gametes during fertilization produces diploid cells (zygote) , therefore the number of chromosomes is consistent in each species and so are the characteristics of the individuals within a species.



Lesson 2: Sexual & asexual reproduction

- Reproduction is the biological process by which an organism produces new individuals of the same kind.
- The purpose of reproduction is the continuity of the species.
- The species is a group of organisms that can breed together to produce fertile **offspring**.
- The parents pass their genetic material (= hereditary material = chromosomes) to their offspring & that's why the offspring have a lot of traits from their parents.

Types of reproduction

Reproduction occurs via 2 methods: sexual reproduction & asexual reproduction.

Points of comparison	**Asexual reproduction**	**Sexual reproduction**
Organisms which reproduce by this method	1. Single cell organisms such as bacteria. 2. Some multicellular organisms such as bread mold.	Occur in multicellular organisms such as plants & animals.
No. of parents	1 parent.	2 parents, a female & a male .
Similarities between the genetic material & the traits of the parent & the offspring	The offspring get identical genetic material of the parent & therefore the traits of the offspring are identical to the parents.	The offspring get the combined genetic material of both parents & therefore the offspring have the combined traits of both parents.
Methods by which it occurs	It has many methods such as budding in yeast & binary fission in amoeba. It doesn't require specialized organs or cells.	It occurs by specialized systems called the reproductive systems.
Type of cell division by which	Mitosis	It requires meiosis to produce male & female
Genetic variation between the parents & the offspring	The offspring have genes as their parents therefore there's no genetic variation between generations.	The offspring have genes from both parents therefore genetic variation between generations exist.

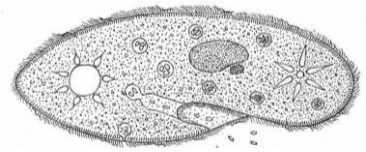
Types of asexual reproduction

1. Binary fission:

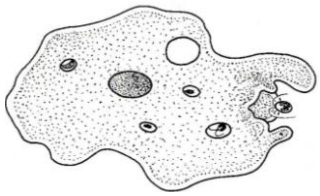
Definition: It is a form of asexual reproduction which occurs in protozoa. The cell divides into two parts & each grows to the size of the original cell.

Examples:

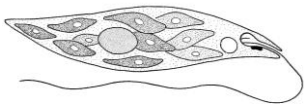
a. Unicellular protozoan such as paramecium, amoeba & euglena.
b. Simple algae
c. bacteria



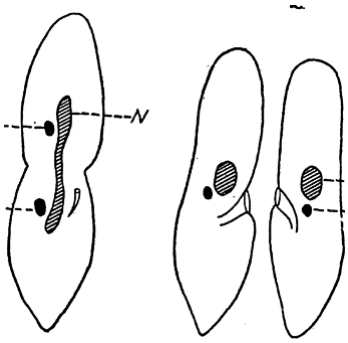
Paramecium



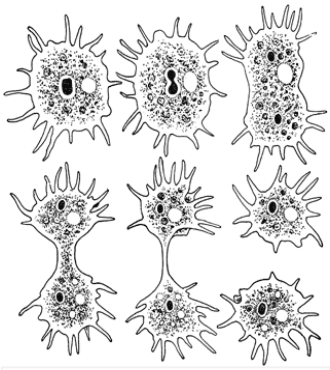
Amoeba



Euglena



Binary fission in paramecium



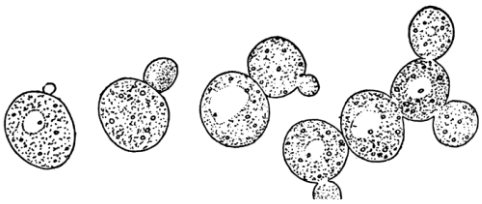
Binary fission in amoeba

2. Budding

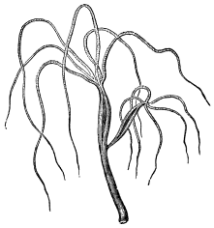
Definition: It is a form of <u>asexual reproduction</u> in which a new organism grows on another one. The new organism remains attached as it grows, separating from the parent organism only when it is mature. Since the reproduction is asexual, the newly created organism is a clone and is genetically identical to the parent organism.

Examples:

a. Unicellular organisms such as yeast fungus
b. Multicellular organisms such as hydra & sponges



Budding in yeast fungi



Budding in hydra

Sponge (a simple marine animal)

An Activity:

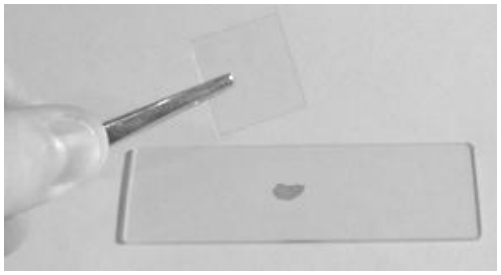
Purpose: To observe budding in yeast fungi

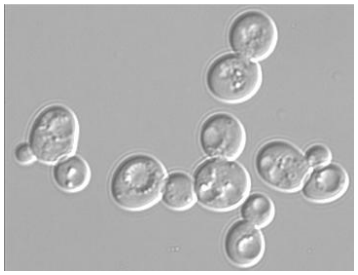
Steps:

1. In a bowl, mix some yeast , sugar & warm water & leave to ferment for 20 minutes.
2. Put a drop of the mixture on a glass slide then cover it with the plastic cover gently.
3. Examine the slide under the microscope.

Observation:

- ❖ A lateral bulge (named bud) appears in the yeast.
- ❖ When it's fully grown, the bulge separates from the parent cell.



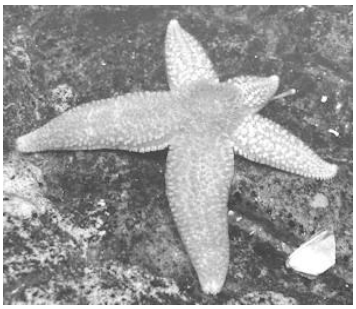


Budding of yeast seen by the microscope

3. **Regeneration**

Among the amazing abilities of starfish is regeneration. A starfish that loses a ray can grow a whole new one in a given time.

Starfish can only regenerate if the central part of the body is intact.



Regeneration is the ability to compensate missing parts in some animals.
Example: Starfish

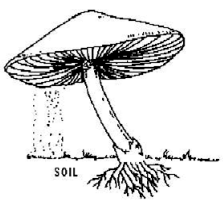
4. Spore propagation

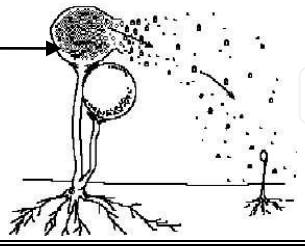
Examples: It occurs in some fungi such as bread mold & mushrooms

Method:

a. Fungi have special structures called sporangia.
b. Each sporangium is a sac like structure that contains a large number of spores.
c. The sporangium bursts open & releases the spores which fall on the surrounding environment.
d. In the presence of suitable conditions in the environment (food , moisture & suitable temperature), the spores grow into full organism of the same kind.

Mushroom is an example of fungi





5. Vegetative reproduction

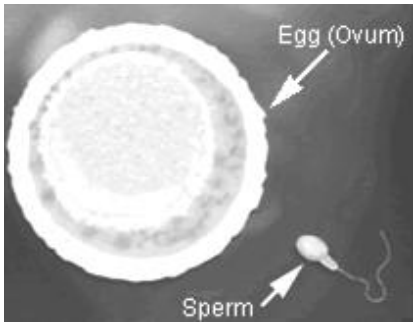
- ❖ It is a form of asexual reproduction in plants.
- ❖ It is a process by which new plants grow from the leaves, stems, or roots of plants without production of seeds.
- ❖ Vegetative reproduction involves mitosis.

Vegetative reproduction from a sweet potato

Vegetative reproduction from a stem cutting

Sexual reproduction

- ❖ It involves a male &female parents.
- ❖ It occurs in higher organisms (plants & animals) because they have reproductive organs & reproductive systems where reproduction occurs.



- ❖ It occurs in 2 steps:

a. Formation of gametes

- ❖ Reproductive cells in the reproductive systems of both males & females divide by meiosis (reduction division) producing gametes.
- ❖ Gametes are produced by meiotic cell division.
- ❖ Gametes are haploid, they contain only one set of chromosomes.
- ❖ **In humans: male gametes are sperm & female gametes are ova (eggs).**

b. Fertilization

- ❖ When the haploid male and female gametes unite by fertilization, they form **a zygote**.
- ❖ The zygote is **diploid** (the number of chromosomes =2n). It contains two sets of chromosomes: one from each parent.
- ❖ The traits of the offspring are the combined traits of both parents.

Explain why sexual reproduction is the source of genetic variation & therefore variation of traits:

a. In sexual reproduction, two individuals produce offspring that have genetic characteristics from both parents. Sexual reproduction introduces new gene combinations in the new individuals.
b. Gametes are formed by meiosis. When crossing over occurs during meiosis, chromosomes exchange parts causing more genetic variation.

Fertilization

Enriching Activity: Preparing a slide of the growing tip of onion's root
Materials:

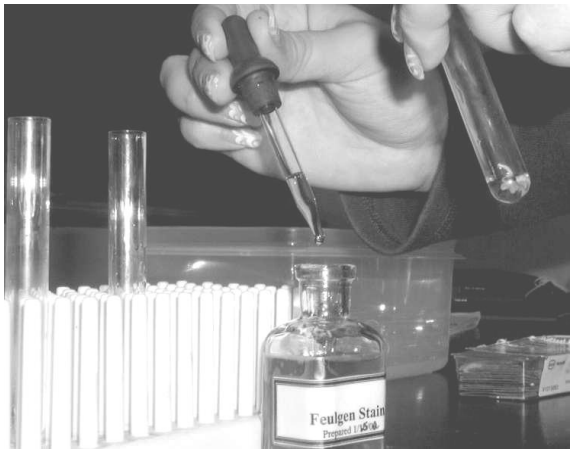
An onion, a beaker that contains a suitable amount of water, compound microscope, a slide & its cover, scalpel , tweezers, 18% HCl solution, fulgent solution, 45% acetic acid solution, test tube , water path

Steps:

1. Plant the onion in the beaker of water until the growth of roots is about 3 cm.
2. Cut a part of the growing root with the scalpel & put it in a test tube.
3. Add few drops of HCl acid in the test tube then put the test tube in a water path for 7 minutes at a temperature 50°C.
4. Wash the roots to get rid of the acid.
5. Add 2 ml of Feulgen (to stain the nucleus) to the roots & leave them for about 30 minutes.
6. Use the tweezers to transfer a root to the glass slide.
7. Cut the growing tip carefully & add 2 drops of acetic acid to it.
8. Cover the sample by the cover slip.
9. Press your thumb against the cover to mash the cells.
10 . Examine the slide under the compound microscope & see the phases of mitosis.

Close up view of different stages of mitosis in an onion root tip:

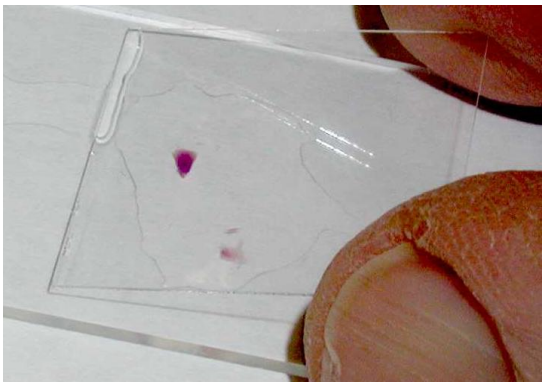
1. **Incubating the root tips with HCl in a water path**



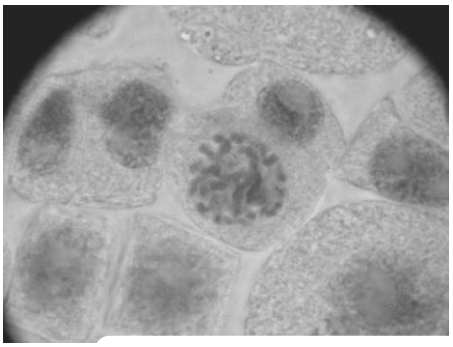
2. Adding feulgen stain

3. The tips have been stained red

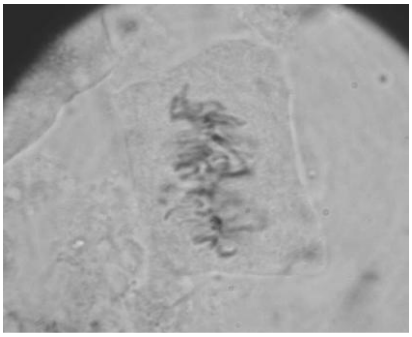
4. Place the soft root tip on the slide.



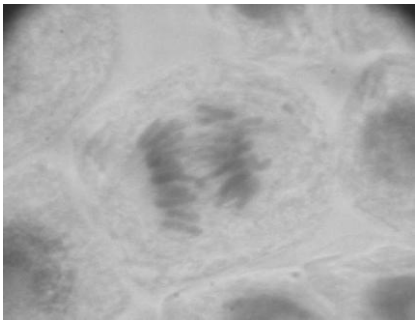
5. Add cover slip



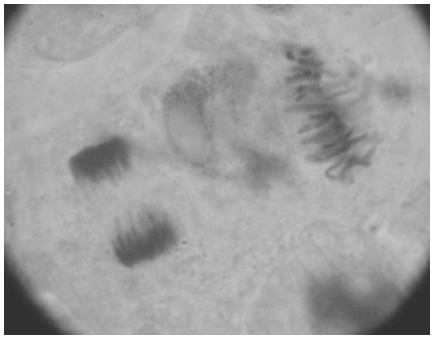
Prophase



Metaphase



Anaphase



Telopahse

The 4 stages of mitosis seen with the microscope

Nanotechnology & treating cancer

- When body cells are exposed to excessive radiation, the cells may divide uncontrollably forming a mass called **tumor.** This disease is cancer.
- Scientists use nanotechnology to develop medicines to treat cancer.
- The medicine acts like a tiny bomb which penetrates the cancer cells killing them. Healthy cells aren't affected.
- An experiment was done to evaluate this experimental medicine as follows.

A group of mice which had cancer were divided into groups:
The experimental group which received the medicine.
The control group which didn't receive the medicine to compare what happens to them with the 1st group.

- **Results:**

a. The experimental group which received the medicine lived 300 days after treatment.

b. The control group which didn't receive the medicine lived 43 days only.

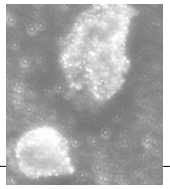
Detecting cancer

- If cancer is detected in early stages, its treatment will be more effective.
- An Egyptian scientist Dr. Mustafa El-Said used nanotechnology to detect cancer.
- He prepared a sample of gold by nanotechnology .
- A specific protein taken from the body was combined with gold then injected in the patient. The protein attached itself to the surface of cancer cells.
- The gold made cancer cells glow. The glow was seen on the monitor of a special microscope.
- Laser beams were directed to the shiny cancerous cells. Laser produced heat that killed infected cells.

Enriching information for reading

Mostafa El-Sayed (born 8 May 1933 - Zifta, Egypt) is:

- a leading nanoscience researcher,
- a member of the National Academy of Sciences and a US National Medal of Sciencelaureate.
- He developed gold nanotechnology which was used to treat cancer .
- **Nanotechnology** studies matter on an atomic and molecular scale & develops materials or devices sized between 1 to 100 nanometer.
- **1 nanometer =** one billionth of a meter (1 nm = 10^{-9} m)



Liver transplant

- In humans , nerve cells don't divide.
- Red blood cells also don't divide. The body replaces dead red blood cells.
- Liver cells don't divide in the normal conditions but when the liver is injured or cut, other cells can divide by mitosis & compensate for the lost part.
- When a person suffers from liver failure , doctors can take a liver lope from a donor & transplant it in the sick person.
- The liver of the donor grows back into the normal size.
- If the person who received the transplant accepts the new liver , it can divide & grow & replace the damaged one.